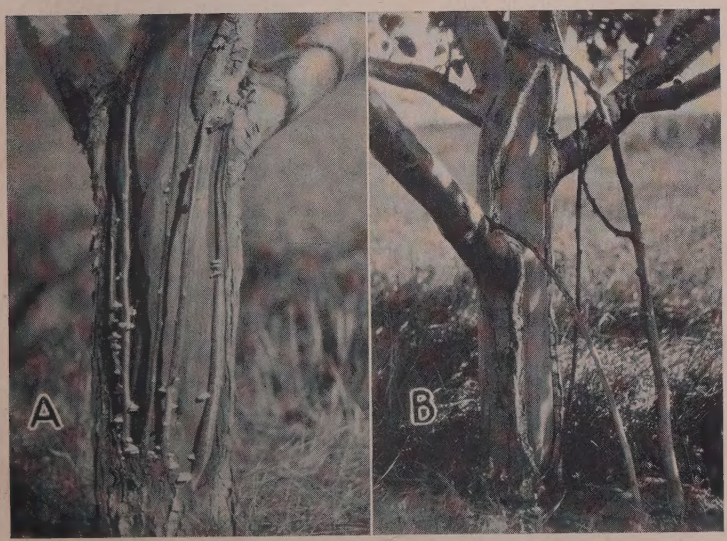
BULLETIN No. 387 JUNE, 1937

The Maine Agricultural Experiment Station

ORONO

Report of Progress for Year Ending June 30, 1937



Bridge-grafting into diseased wood (at left) permits fungus to prevent success such as attends inarching seedling supported by own roots (at right)

UNIVERSITY OF MAINE
THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

THE STATION COUNCIL

PRESIDENT ARTHUR A. HAUCK,	President
DIRECTOR FRED GRIFFEE,	Secretary
FRANK P. WASHBURN, Augusta,	Committee of
THOMAS E. HOUGHTON, Fort Fairfield,	Board of Trustees
JOHN T. GYGER, Portland, R.F.D. 4	
FRANK P. WASHBURN, Augusta,	Commissioner of Agriculture
FRANK A. POTTER, Bangor,	State Grange
WILSON H. CONANT, Buckfield,	State Pomological Society
ROSS ELLIOTT, East Corinth,	State Dairymen's Assn.
FRED J. NUTTER, Corinna,	Maine Livestock Breeders' Assn.
WILLIAM G. HUNTON, Portland,	Honorary Member
CHARLES C. CLEMENTS, Winterport,	Maine Poultry Improvement Assn.

And the Heads and Associates of Station Departments, the Director of the Extension Service, and the Dean of the College of Agriculture

THE STATION STAFF

Administration
Fred Griffee, Ph.D., Director
Charles C. Inman, Administrative Assistant
Mary N. Cameron, Secretary
Rose H. McGuigan, Stenographer
Lillian M. Marquis, Stenographer
Irvill H. Cheney, B.S., Superintendent of Highmoor Farm
Silas O. Hanson, Superintendent of Aroostook Farm

Agricultural Economics
Charles H. Merchant, Ph.D., Head of Department
George F. Dow, M.S., Associate Economist
William E. Schrumpf, M.S., Assistant Economist
Andrew E. Watson, M.S., Acting Assistant Economist
Elaine M. Pooler, Chief Assistant
Magretta Blackmore, Assistant

Biology
W. Franklin Dove, Ph.D., Head of Department
John W. Gowen, Ph.D., Collaborating Biologist, Animal Breeding
Joseph A. Chucka, Ph.D., Associate, Plant Breeding and Nutrition
Russell M. Bailey, B.S., Associate, Plant Breeding and Nutrition
Frederick B. Chandler, B.S., Assistant, Blueberry Investigations
Delmar S. Fink, Ph.D., Assistant, Plant Breeding and Nutrition
Irvin C. Mason, M.S., Assistant, Blueberry Investigations
Delmar B. Lovejoy, M.S., Assistant, Plant Breeding and Nutrition
Arthur Hawkins, M.S., Assistant, Plant Breeding and Nutrition
Frank Chadwick, Jr., B.S., Assistant, Animal Breeding
Elizabeth F. Murphy, M.A., Assistant, Animal Breeding and Nutrition
Iva M. Burgess, M.S., Assistant
Mildred R. Covell, Assistant
Emmeline W. Kenney, Laboratory Assistant
Belle Dall, Clerk

Chemistry
Elmer R. Tobey, M.S., Ch.E., Head of Department
C. Harry White, Ph.C., Associate, Inspection Analyses
Bernie E. Plummer, Jr., M.S., Associate, Inspection Analyses
Glenn H. Perkins, M.S., Assistant, Inspection Analyses
Millard G. Moore, M.S., Assistant, Inspection Analyses
George P. Steinbauer, Ph.D., Seed Analyst
Charles A. Brautlecht, Ph.D., Collaborator

Entomology
Edith M. Patch, Ph.D., Head of Department
Frank H. Lathrop, Ph.D., Entomologist
John H. Hawkins, Ph.D., Assistant
Geddes W. Simpson, Ph.D., Assistant
Alice W. Averill, Laboratory Assistant

Home Economics
Pearl S. Greene, M.A., Head of Department
Marion D. Sweetman, Ph.D., Collaborating Home Economist
Mary M. Clayton, Ph.D., Nutritionist
Merna M. Monroe, M.S., Assistant

Plant Pathology
Donald Folsom, Ph.D., Head of Department
Reiner Bonde, M.S., Associate
Merle T. Hilborn, M.S., Assistant
Ruth W. Bowers, Laboratory Assistant and Assistant in Seed Analysis

CONTENTS

	PAGE
Introduction	157
Aphid studies	157
Investigations with peas	157
Apples	161
Apple breeding	161
The relation of size of tree at time of setting to size in later years	161
Winter injury in relation to growth	162
Apple pollination	163
Intersterility of McIntosh strains	163
Natural pollination compared to artificial pollination	163
How late in the fall do apples grow?	163
Apple storage studies	164
Wound dressings for winter injured apple trees	165
Apple scab control	169
Twenty-three-year-old McIntosh trees	169
Young McIntosh trees, ninth year	170
Insects affecting the apple crop	171
The gypsy moth in Maine apple orchards	172
The apple fruit fly (*Rhagoletis pomonella* Walsh)	175
The plum curculio (*Conotrachelus nenuphar* Herbst)	175
The apple seed chalcid (*Syntomaspis druparum* Boheman)	177
Canning crops	178
Sweet corn breeding	178
Sweet corn fertilization	179
Investigations with beans	180
Field bean planting rate study	180
Progress in breeding snap beans	181
The Mexican bean beetle	181
Chemistry	183
Chemistry investigation	183
Dairying	185
An economic study of the dairy industry in Maine	185
Milk production costs in herds of producer-distributors	186
Milk distribution costs in Maine markets	190
Dairy farm organization and management studies	194

Farm credit 195
Farm credit in Maine 195
Foods and Nutrition 195
A study of the food habits and the nutritional status of children in selected communities in Maine 195
A study of the relation of man and animals to the environment 197
Garden crops 201
Cultural and breeding studies 201
Variety tests 201
Lettuce 201
Hay mulch on lettuce 202
Tomato breeding 202
Cucumber breeding for resistance to scab (*Cladosporium cucumerinum*) 202
Boron deficiency in cauliflower and related plants 202
Control of the striped cucumber beetle 203
Grassland management 206
Pasture improvement 206
Household equipment 207
The economical management of kerosene cook stoves to secure palatability of product in Maine farm households 207
The effect of the method of heat application, and accompanying oven conditions, upon flavor and texture of baked foods 210
Inspection service 211
Work of inspection service 211
Testing of dairy glassware 212
Fertilizer inspection 212
Agricultural seeds, insecticides and fungicides inspection 212
Food and drug inspection 212
Feeding stuffs inspection 212
Gasoline inspection 213
Motor lubricants inspection 213
Land use 213
Land use studies in Maine 213
Soil survey 213
Potatoes 214
An economic study of the potato industry in Maine 214

Costs and returns in producing potatoes in Aroostook County, Maine 214
Costs and returns in producing potatoes in central Maine with comparisons 214
Cost of growing potatoes 216
Cost of harvesting potatoes 216
Relation of the combined cost of growing and harvesting potatoes to the yield rate 216
Cost of storing potatoes 218
Cost of selling potatoes 218
Relation of the cost of selling potatoes to the amount sold 219
Farm organization of potato farms in Aroostook County, Maine, in 1935 compared with 1928-1930 219
Farm acreage 220
Crop acreage 221
Livestock 222
Farm capital 222
Capital in real estate 222
Capital in machinery 223
Fertilizer experiments with potatoes in permanent plots ... 224
Potato fertilizer tests conducted on privately owned farms throughout Aroostook County 225
Potash-magnesium test 225
Acid versus neutral fertilizer test 225
Rate of fertilizer test 225
Seed spacing-rate test 225
Uncommon element test 226
Source of phosphorus test 226
Cooking qualities of potatoes 226
Green Mountain seed plots 227
The value of selecting seed stock that is free from rhizoctonia 228
Spraying and dusting potatoes 229
Comparison of different spray schedules 230
Yield at different dates of potatoes receiving different fungicidal treatments 230
The effect of added compounds on the adhesiveness of Bordeaux mixture and copper lime dust 231
Production of a late blight or rust epidemic on Aroostook Farm in 1936 232
Comparison of Bordeaux mixture and basic copper sulphate 233

Dusting vs. spraying of potatoes of different varieties... 235
Other comparisons of spray fungicides..... 236
Yield comparison with dolomitic hydrated lime vs. high calcium hydrated lime in the preparation of Bordeaux mixture 237
Yield comparison with different amounts of lime in the formula for making Bordeaux mixture..... 238
Spray service 239
New rust resistant varieties of potatoes..... 240
Insects in relation to the transmission of virus diseases.... 241
Control of flea beetles on potatoes..... 243
Potato starch 243
Small fruits..... 243
Variety trials of strawberries, raspberries, and grapes..... 243
Strawberries 243
Raspberries 243
Grapes 244
Blueberry investigations..... 244
Pollination 244
Breeding and variety testing..... 244
Field management of the blueberry..... 244
Weed control 245
Blueberry insects..... 245
Blueberry fruit fly (*Rhagoletis pomonella* Curran)..... 245
Non-arsenical dust for blueberry fruit fly..... 245
The blueberry thrips (*Frankliniella vaccinii* Morgan).. 246
The blueberry flea beetle (*Haltica torquata* LeConte)... 246
Announcements 246
Projects for 1936-1937..... 248
Publications 251
Bulletins issued in 1936-1937..... 251
Official inspections issued in 1936-1937..... 251
Abstracts of papers published by the Station in 1936-1937 but not included in the bulletins..... 251
Winter injury to apple trees..... 251
Some Epixylous fungi of Maine..... 252
Report on wound dressings used in the college orchard during 1934 and 1935..... 252
A bacterial wilt and soft rot of the potato in Maine..... 253
Breeding for resistance to late blight in the potato..... 254
Recent developments in potato breeding for resistance to virus diseases..... 255

Some observations and current studies of winter injury to apple 256
Wireworm control in relation to potato growing 256
Meteorological observations 257
Report on the finances of the Station 261

INTRODUCTION

The progress of the research program for the fiscal year 1936-37 just completed is given briefly in this report. Seldom is it possible to draw definite conclusions on the basis of the results from one year's study. Negative evidence during one season may be conclusive, but positive evidence, in order to be conclusive, requires at least several years to assure the testing of methods or materials under varying conditions such as temperature, rainfall, snow cover, etc. The research program is designed to provide the agriculture of the State with information to aid in efficient and economical production. To this end the results of research frequently point out ways and means for increasing production per acre or per unit of labor. The information, therefore, allows the producer to bring his goods to market at a lower cost to him and to the consumer. Or it may provide the consumer with a high quality product at the same price he has paid formerly for an inferior one. A well-planned research program has no bearing whatever on the overproduction "dummy" that has been so frequently put up for someone to knock down. On the contrary, the results of carefully conducted research provide the only basis for sound thinking and planning.

APHID STUDIES

Investigations with Peas. John H. Hawkins. Destructive attacks by pea aphids have been observed in Maine for many years. Dr. Patch reported that during 1926 the pack of one canning company was but 27 cases of peas per acre as compared with 100 cases in 1925.[1] It is difficult to estimate the annual loss caused by aphids to the pea crop but it is evident that the damage varies from a negligible amount in lightly infested fields to a total loss in fields heavily infested. The degree of infestation varies from year to year and with fields and localities.

The economic production of canning peas is therefore directly connected with the amount of injury inflicted on the pea crop by

[1] Patch, E. M., The Pea Aphid in Maine. Me. Agr. Exp. Sta. Bul. 337, p. 9. 1927.

the aphids. To the rapidly expanding industry of growing canning peas, the pea aphid is a direct threat. Because of this, active investigation of the pea aphid and its control has been resumed in Maine.

The problem of pea aphid control has been given considerable attention in several states where peas are grown for canning. In past years many methods of control have been attempted. One of the first methods was to collect the aphids by the use of a mechanical apparatus known as the aphidozer. Although countless millions of aphids were collected from infested fields and destroyed, the aphidozer was not thoroughly effective because usually there were enough aphids left in the field to produce a new infestation.

Nicotine was one of the first insecticides used in pea aphid control. It is used both as a spray and as a dust. Nicotine dust was extensively used for a time. When combined with lime, nicotine gives off a gas which is toxic to aphids. The evolution of the gas depends upon a high temperature. To be effective it must be confined in the immediate vicinity of the aphids. A long canvas apron or trailer attached to the power duster is used to confine the gas. This method has not been popular in Maine because the occurrence of high temperatures cannot be relied upon and because the heavy canvas apron is unwieldy and difficult to manage among the growing peas. More recently nicotine has been combined with copper sulphate so that heat is given off by the chemical action in the mixture, and high outdoor temperatures are therefore not so essential to evolution of the gas. Also, trailer aprons are now made of much lighter material and are said to be gas proof, and the method of handling them in the pea fields has been improved.

Lately the use of the so-called nicofumer has apparently increased the usefulness of nicotine in pea aphid control. The nicofumer is an apparatus arranged for pumping nicotine into the hot exhaust pipe of a motor truck. This causes a gas to be formed which is expelled beneath a long, light, gas-proof trailer.

Rotenone, a comparatively new insecticide, is now extensively used in pea aphid control. The results from the use of rotenone have been variable, but in general it is a promising material. Rotenone is somewhat slower in its action than some other insecticides but remains effective for about a week after its application. Those who have used rotenone extensively for pea aphid control are of the

opinion that its effectiveness depends upon the rotenone content of the spray or dust, the use of a suitable wetter and spreader, and the thoroughness of application. There is also a tendency to recommend that materials used in rotenone-bearing sprays and dusts be ground very fine and even. Some investigators maintain that, with rotenone, spraying is more effective than dusting for control of the pea aphid. Others hold the opposite view. Neither method is effective unless applied with machinery powerful enough to drive the dust or spray into the buds and among the pea vines so that the insecticide comes in contact with practically all of the aphids. The greatest kill from the use of rotenone comes after the sixth or seventh day following application according to observations made in Maine as well as in other states.

A recent development in pea aphid control is the use of highly concentrated rotenone or of nicotine in a liquid base, the base often being a light highly refined oil. A truck is used to carry the apparatus which consists of an air compressor and nozzles for atomizing the material. Insecticides of this type are also used with airplanes as the means of distributing the control materials.

As indicated previously, observations and experiments resumed in a preliminary way in Maine in 1935 had as an objective the economic and practical control of the pea aphid. A study was at once begun to test under Maine conditions the best methods of control now in general use. This study is going forward at the present time with emphasis on the use of rotenone. Preliminary experiments with hand apparatus strongly indicate that an effective wetter and spreader is necessary for satisfactory control. Observations up to this time also indicate that the general findings of others apply to control under Maine conditions regardless of whether hand operated or power apparatus is used. The percentage of rotenone, the fineness of materials, the presence of an effective adhesive wetter or spreader, thoroughness of application, proper timing of application of the insecticide in relation to the presence of aphids on the peas, and weather conditions, all may influence the effectiveness of the dust or spray.

There is a difference of opinion as to the proper time for applying the insecticides. Observations in Maine during the past three years have led to the conclusion that the stage of growth of the pea vines is an important consideration in timing the sprays. If aphids

are present when the peas are in bloom they are a potential threat to the crop. Rotenone applied then will remain effective for about a week and under Maine conditions a second application may rarely be necessary. Data at hand also indicate that if large numbers of aphids are present when the peas are well formed in the pods, it is likely to be too late to prevent serious injury. If pea aphids are to be effectively controlled, the treatment should be applied before excessive injury to the vines occurs. It appears evident from somewhat limited observations that when aphids are present at the time peas are in the blossom stage, the control should be applied as soon as possible, for serious injury may follow the presence of only a few aphids within a very few days.

Weather plays an important part in aphid abundance. It affects the aphids indirectly through the host plant and through influencing the abundance and activity of the parasites and predators. It directly affects the aphids themselves. Low temperatures and wet weather did not prevent the survival of pea aphids during the spring of 1937. However, high temperatures and high humidity later affected the aphids in two ways. First, apparently the high temperatures were favorable to rapid reproduction and, second, the high temperature combined with the high humidity was favorable to a parasitic fungus disease which killed large numbers of the aphids. This fungus is an important parasite of the pea aphid. Unfortunately it propagates rapidly only after the aphids become excessively numerous. According to observations in Maine the fungus does not prevent the increase in aphid population up to a certain point. This point is often beyond that at which injury is done to the peas. The fungus does sometimes check or completely control infestations of aphids when weather conditions are favorable to the rapid spread of the disease.

During 1936 there was a notable scarcity of parasitic and predaceous enemies of the pea aphid until the fungus disease appeared. During 1937 many more predators and at least one important insect parasite were present before the fungus disease appeared. Syrphid maggots, adult ladybird beetles, and the larvae of the golden eye lacewing were all present in the pea fields feeding upon aphids during May and June, 1937. The ladybird larvae and the syrphid larvae were especially abundant and destroyed large numbers of aphids. A parasitic grub of a small wasp-like insect belonging to

the family Braconidae parasitized great numbers of aphids during 1937. It is evident that insect parasites and predators were factors in preventing excessive damage by pea aphids during the early part of the season of 1937.

Efficient control is dependent upon a knowledge of the life history of the pea aphid. For this reason observations on the life history are being conducted. It was found that on May 25, 1937, wingless female aphids were present in clover fields. Winged females were beginning to appear in small numbers by June 3 and were more abundant by June 10. On June 14 a severe infestation of pea aphids was observed on early peas. Large numbers of aphids were present in the pea fields by July 1 and considerable damage was being done. In certain fields control measures were needed before the middle of June. In other fields the aphids were not a factor at that time.

APPLES

Apple Breeding. Russell M. Bailey and Iva M. Burgess. The seedling orchard at Highmoor Farm has gradually been increased in size until at present approximately 1000 seedlings of varying ages from controlled crosses are under study. McIntosh, Golden Delicious, Red Delicious, Northern Spy, Cortland, Haralson, and Scott Winter comprise the parental material combined in different ways in an attempt to provide populations that will facilitate the production of better late varieties suited to Maine. Efforts are being made in this project to evaluate the material for relative winter hardiness and vitamin C potency.

The Relation of Size of Tree at Time of Setting to Size in Later Years. Russell M. Bailey and Iva M. Burgess. In an effort to determine the relative importance of genetic differences in the stock and of environmental factors to tree size in later years, the trunk diameter measurements of approximately 1800 apple trees have been taken yearly (for the past 8 to 10 years). The trunk diameter at time of setting has been correlated with that found during each year of the study. The following data obtained by averaging the correlation coefficients of several McIntosh groupings in one orchard illustrate the general trend.

Correlation Coefficient Obtained by Correlating 1925 Diameter at Time of Setting with Diameter in Later Years

Year	Average Coefficient	Year	Average Coefficient
1926	.8908	1932	.5228
1927	.7298	1933	.4964
1928	.6729	1934	.4879
1929	.5951	1935	.4899
1930	.5553	1936	.4622
1931	.5376		

These data show a very rapid drop during the first few years after setting.[2] On the assumption that size differences in the trees in the nursery row were largely due to inherent differences in the rootstock, the above data suggest that environmental factors have been more important in determining the present size of tree than genetic differences in the stock employed. Further data are necessary to determine if the effect of environmental factors has been fully expressed.

WINTER INJURY IN RELATION TO GROWTH. Russell M. Bailey and Iva M. Burgess. In a block of approximately 225 apple trees set alternately to Baldwins and McIntosh in 1927, the growth of the Baldwins as indicated by trunk diameter measurements has been only slightly less than that of the McIntosh. In the summer of 1934 the Baldwin trees exhibited, in the younger limbs, symptoms of injury that occurred during the previous winter. Although there was no complete killing of limbs, browning of the previous year's wood was generally noted. The McIntosh showed no symptoms of injury. Difference in trunk diameter increase of the two varieties in 1934, the summer following the injury, was not more than normal. However, in 1935 growth of the Baldwin trunks was markedly reduced and again in 1936 but to a lesser degree. This appears to be an example of the harmful influence of even comparatively mild winter injury on growth. The following data present the summarized results.

[2] As indicated above, the correlation coefficients are still declining in value yearly but progressively less on the average each year. Nearly all the correlation coefficients in the study are still highly significant.

Year	Trunk diameter increase in millimeters		Difference
	Baldwin	McIntosh	
1928	4.57	5.58	1.01
1929	7.51	7.91	0.40
1930	12.61	12.85	0.24
1931	13.35	15.07	1.72
1932	12.60	14.25	1.65
1933	11.21	12.93	1.72
(winter injury)			
1934	12.44	13.00	0.56
1935	10.09	13.19	3.10
1936	11.19	14.05	2.86

Apple Pollination. Russell M. Bailey and Iva M. Burgess. *Intersterility of McIntosh Strains.* The intersterility of the two McIntosh apple strains bearing fruit in the Highmoor Farm orchard was again tested in 1936. This work was first done in 1935 and reported in Bulletin No. 380. The 1935 and 1936 data are in agreement, indicating that the two strains (solid blush and striped blush) are highly intersterile. This information suggests that the two strains are closely related genetically and that one probably originated by mutation from the other rather than by the like naming of similar seedlings.

Natural Pollination Compared to Artificial Pollination. This study is in progress in order to determine if adequate pollination occurs in the orchard without the introduction of cultivated bees or of additional compatible pollen. On trees scattered throughout the orchard the fruit set of artificially pollinated limbs has been compared with naturally pollinated limbs. A compatible pollen from a diploid variety has been used in all the artificial pollinations. Three years' data have been obtained, but further data covering several more years will be necessary before definite recommendations can be made. Thus far, no significant increases in fruit set have been obtained through artificial pollination.

How Late in the Fall Do Apples Grow? Russell M. Bailey. In 1936 at Highmoor Farm, apples on 12 trees of McIntosh, Cortland, Golden Delicious, and Northern Spy (3 trees of each variety) were numbered with waterproof ink and their diameter measurements recorded each week until either cold weather or excessive dropping forced discontinuance of the observations. This work was done to check the observations reported in the

Report of Progress, Bulletin 380, page 207, 1935, that indicated substantial growth increases late in the season.

Table 1, summarizing the data obtained, shows that apples continue to grow as long as they can be left on the trees.

TABLE 1

Showing Average Apple Diameter Measurements, and Yield Increases in Relation to Different Calendar Dates in 1936

	Sept. 6	Sept. 13	Sept. 20	Sept. 28	Oct. 5	Oct. 12	Oct. 19	Oct. 26
	Average diameter measurements in mm.							
McIntosh	66.2	68.1	70.1					
Cortland	73.5	75.3	76.3	78.5				
Golden Delicious	61.9	63.8	65.7	66.5	66.8	67.7		
Northern Spy	64.5	65.8	66.3	68.4	69.5	70.1	70.4	70.8
	Accumulated increase in bushels for each date (assuming an apple to be a sphere and the crop at 100 bushels on first date of measurement)							
McIntosh	100 bu.	109 bu.	119 bu.					
Cortland	100	108	112	122 bu.				
Golden Delicious	100	109	120	124	125 bu.	131 bu.		
Northern Spy	100	106	109	119	125	128	130 bu.	132 bu.

It would seem that the proper time to pick depends upon striking a balance between increasing yield due to fruit enlargement and to loss by dropping, also taking into consideration larger size and better color of late picked fruit.

APPLE STORAGE STUDIES. Russell M. Bailey and F. B. Chandler. For two years McIntosh, Cortland, Golden Delicious and Northern Spy apples have been picked at three to five day intervals during the harvest period and placed in storage at Highmoor. Records of color, size, quality, and shrinkage from rot and water loss have been kept. Marked differences in color, quality and size were observed favoring late picked fruit in all cases. Very late picked McIntosh (about October 5th) tended to break down rapidly. Golden Delicious picked very late (about October 20th), although excellent in flavor, showed excessive development of red spots. With all varieties, more loss from rot was experienced in late picked fruit but it would seem that superior color, size, and quality would compensate for this. No appreciable difference in water loss due to picking date could be detected from the data obtained.

Studies are in progress on the use of different types of wrappings and waxing for apples. Cellophane is very effective in reducing water loss but epidermal scald is severe after removal from storage. Waxing Golden Delicious with a carnauba wax emulsion has effectively reduced the water loss 25 to 50 per cent when the fruit was placed under very dry and warm conditions. Waxing does not appear to be detrimental to the flavor.

Wound Dressings for Winter Injured Apple Trees. M. T. Hilborn. The prevalence and severity of trunk and crotch injuries on apple trees, particularly McIntosh, were enough in 1934 and 1935 to warrant a study of the comparative efficiency of various wound treatments. Preliminary treatments in 1934 were not satisfactory. In 1935 an experiment was laid out to test some of the wound dressings then in use in Maine and elsewhere. A total of 180 wounds, following winter injury to the trunk, were found in a block of McIntosh trees in the College orchard at Orono and were used in the experiment. Eighteen kinds of treatments were tried on these, each treatment being repeated nine times, with the replications scattered throughout the block of trees. The area of each wound was measured and wounds of similar size were equally distributed among the different treatments. Measurements were made, at the end of each of the growing seasons of 1935 and 1936, of the amount of callus growth on each wound. Notes were taken of the condition of the wound dressing at various times during each year, particularly as to its durability and its effectiveness in preventing the entrance of decay organisms and wood-boring insects.

The total callus growth made during the growing seasons of 1935 and 1936 was analyzed by Fisher's method of variance to determine the significance of the treatments. The resulting data are presented in Table 2.

TABLE 2

Analysis of Variance in Callus Growth as Affected by Treatment and Location of 180 Wounds on McIntosh Trees

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	179	1379.8	——
Between means of observations	17	23.0	1.35
Between means of treatments	9	231.6	25.73
Remainder, interaction	153	1125.2	7.35

This analysis of variance shows that tree vigor and location of wounds had a nonsignificant effect on callus formation. The kind of wound treatment, however, had a highly significant effect. The fact that tree vigor, as measured by trunk increase, has not influenced callus growth much is further brought out when trunk increment and callus growth are correlated. The correlation coefficient in 1935 was only $0.191 \pm .045$, and in 1936 it was only $0.382 \pm .052$.

If the total amount of callus growth is compared for each of the treatments *vs.* no treatment, it is evident that some of the treatments have retarded callus formation quite definitely while others have increased it. This is shown in Table 3.

TABLE 3

Average Callus Growth in Millimeters for 1935 and 1936 Together

Treatment	Average callus growth in mm.
Leonard Tree Compound	61
Liquid Elastigum	58
Shellac	57
Valdura	57
Paraffin	56
Grafting Wax (Clarion)	56
Grafting Wax (Hunt & Sons)	53
White Lead and linseed oil	49
Cut Check (no disinfectant)	48
Grafting Wax (homemade)	47
Cut Check (disinfectant)	46
Corona	42
Plastic Elastigum	40
Clintark	38
Vultex	37
Hood River Tree Paint	36
Bordeaux (linseed oil)	36
Bordeaux (rapeseed oil)	28

In Table 3 the standard error of the difference is 1.2, which when divided into the difference between the cut checks and the other treatments, and compared with the value for t in Fisher's tables shows that significant differences exist between most treatments and the cut checks. The Leonard Tree Compound, Liquid Elastigum, Shellac, Valdura, Paraffin, Grafting Wax (Clarion), and Grafting Wax (Hunt & Sons) have all increased callus formation significantly. Corona, Plastic Elastigum, Clintark, Vultex, Hood River Tree Paint, and the two Bordeaux treatments have retarded it significantly. Thus the often repeated statement that any wound dressing will retard callus formation does not hold true for these data.

The requirements of a good wound dressing are listed elsewhere.[3] Of these perhaps the two most important are durability and ease in application. The black compounds, Liquid Elastigum, Leonard Tree Compound, and Valdura, all showed a tendency to peel off when put on the southwest side of the tree. The Paraffin and the three types of Grafting Wax were very susceptible to changes in temperature, so that they ran off during the summer and cracked in the winter. The Clintark material showed a tendency to pull away where the callus formed and the surface of the material cracked easily. The Hood River Tree Paint, after weathering, formed a deposit of copper oleate which soon flaked off leaving behind an unsightly, varnish-like deposit of rosin which was not durable. Fig. 27 illustrates some of these treatments. Vultex did not last for more than a few months. The White Lead and linseed oil mixture was not effective for more than one year. The Plastic Elastigum was durable but, like the Paraffin and Grafting Waxes, it was very difficult to apply. The Plastic Elastigum also formed a thick impervious coating over the surface which in turn formed water pockets at the base of the wound. The two Bordeaux treatments were both satisfactory as to durability. They stay on for at least two or three years, and apparently act as a satisfactory disinfectant, thus requiring only one treatment to a wound. A disinfectant should precede the application of any of the other wound dressings. The checks were in poor condition; the surface of each wound was badly cracked, and disease and wood-boring insects were active.

On the basis of callus formation those wound dressings that were the least durable permitted, in general, the best callus growth. The observations made during the years that these treatments have been on the trees, however, indicate that durability is a more desirable quality for a wound dressing than rate of callus growth. On this basis the Bordeaux and linseed oil mixture appears to be the best treatment. No advantage could be found in using rapeseed oil as a substitute for linseed oil.

The severity of the damage to McIntosh trunks in some orchards is severe enough so that other aids must be employed to pro-

[3] Hilborn, M. T. Report on wound dressings used in the College orchard during 1934 and 1935. Ann. Rpt. Maine State Pomol. Soc. 1934-35, pp. 44-47.

FIG. 27. Durability of wound dressings. All photographs taken in July, 1936. A. Cintark on left side of trunk, Valdura on right side. B. Hood River Tree Paint. Notice flaky deposit of copper oleate. C. Bordeaux and linseed oil. D. Check.

mote good growth. Bridge-grafting and inarching will prove valuable where more than one-third of the bark has been killed. It is of no use to bridge-graft into wood that is diseased. See Fig. 28. The bark should be cut back until living, green tissue is reached.

Fig. 28. Bridge-grafting and inarching. A. Effect of bridge-grafting into diseased wood. Notice fruiting bodies of the decay-causing fungus *Schizophyllum commune* on both the scions and the surface of the wound. B. Inarching a wild seedling planted at base of tree.

Other wound dressings are under observation at Orono for their durability. These include Cabot, Sav-a-tree, Sherwin-Williams Pruning Compound, and Tremco.

Apple Scab Control. Donald Folsom. Apple scab control was studied in two orchards on Highmoor Farm, with special attention given to the growth rate and yield of fruits as affected by spray materials.

Twenty-three-Year-Old McIntosh Trees. In 1936, two rows of 23-year-old McIntosh trees, 20 to a row, were compared when receiving two different strengths of lime sulphur respectively. Both rows were sprayed with the same equipment and strengths of mixture as in 1935, in which year half strength was associated with a

surprisingly large increase in yield rate. About 900 leaves and 2000 apples from each row were examined, and other measurements made, with the following results:

Strength	Full	Half
Leaves scabby	0.7%	3.1%
Leaves burned	32%	13%
Fruits scabby	1.7%	4.1%
Fruits russeted	1.0%	0.9%
Average trunk girth (in spring)	59.2 cm.	58.8 cm.
Average girth increase	2.9 cm.	3.1 cm.
Fruit yield per tree	8.8 bus.	7.3 bus.

By full strength is meant one gallon of liquid lime sulphur to 50 gallons of mixture. Six applications were made during the season. The reduction in strength was this year associated with a decrease in yield, though it lessened leaf burning. It permitted more scab to develop on both leaves and fruit. The yield for both seasons combined was 15.3 bushels from the full-strength row and 15.7 bushels from the half-strength, a difference without significance.

In both rows a significantly greater yield of fruit was secured from the trees having larger trunk girth as measured in the spring of 1936 ($r = +0.539$). The trees bearing larger crops made significantly less increase in girth ($r = -0.581$) during the summer. The history of the two rows as charted for yield shows them closely parallel from 1923 to 1934. However, as a result of the difference in treatment, a great variation in yield occurred in 1935 when the half-strength row yielded 29 per cent more than the full-strength, and in 1936 when the full-strength row yielded 21 per cent more than the half-strength.

Young McIntosh Trees, Ninth Year. In 1936, 360 young McIntosh trees were continued in five series. Each series received the same spray or dust treatment for the ninth consecutive season, except for one series being changed from a lead-arsenate treatment to a lime-sulphur treatment. About 66 per cent of the trees produced fruits, a decrease from 1935 in percentage and in yield rate occurring as the result of frost injury during the third week of May, 1936.

On July 28, 1700 leaves were examined in each series of trees, 100 leaves to a tree. Most of the fruits, up to a total of about 11,000, were examined. Results are given in Table 4. The unusual

lack of good control by the fungicides is attributable to the unavoidable postponement of the first cover application until 16 days after the calyx application.

TABLE 4

Current-Season Effects of Spray and Dust Materials on Apples, 1936

Treatment	Per cent leaves scabby	Per cent leaves burned	Per cent fruits scabby	Per cent fruits russeted
Dry lime-sulphur spray	8.4	44.8	2.0	0.2
Ditto, for the first time; lead arsenate previous years	11.2	32.5	7.2	0.1
Wettable flotation sulphur spray	14.2	8.0	2.6	0
Bentonite sulphur dust	12.7	7.8	4.0	0
Nothing (checks)	24.9	17.9	33.2	0

The effects of the same kinds of spray and dust treatments applied during consecutive years are shown in Table 5. As com-

TABLE 5

Cumulative Effects of Spray and Dust Materials on Apple Trees, Nine Years Ending 1936

Treatment	Trees		Trunk girth			Fruits		Fruit buds produced 1936[1]
	Total	Per cent fruiting	Increase (cm.)	Final (cm.)	Ratio	Pounds per tree	Ratio of yield rate	
Lime sulphur	67	66	4.40	26.5	1.01	7.3	1.00	2.64
Ditto, for the first time; lead arsenate previous years	68	71	4.01	26.8	1.02	10.0	1.37	2.21
Sulphur spray	66	73	4.23	27.4	1.05	9.4	1.29	2.62
Sulphur dust	65	72	4.17	26.8	1.02	13.9	1.90	2.55
Nothing (checks)	75	61	4.05	26.2	1.00	8.4	1.15	2.44

[1] Estimated from blossoms in spring of 1937 in 6 grades from 0 (none) to 5 (most).

pared with the results of the previous year, differences in percentage of trees fruiting have largely disappeared and the yield rates are more nearly alike for the different treatment-series of trees. Although lime sulphur seems to have retarded fruit production considerably, the difference is generally not statistically significant and the lime-sulphur series this year shows the greatest increase in trunk girth.

INSECTS AFFECTING THE APPLE CROP. Frank H. Lathrop. During the past year studies of the biology and control of important

apple insect pests have been continued. As a result of the study there is accumulating a fund of exact biological data that will be of value in planning more effective and more economical spray programs. Parallel with the biological studies, spray tests are being conducted in commercial orchards near Highmoor Farm.

The Gypsy Moth in Maine Apple Orchards. During the past few years the gypsy moth has presented a problem of increasing importance in orchards located near infested woodland. Observations of the situation show that the problem may be divided into three phases: 1. The control of larvae that hatch from eggs that

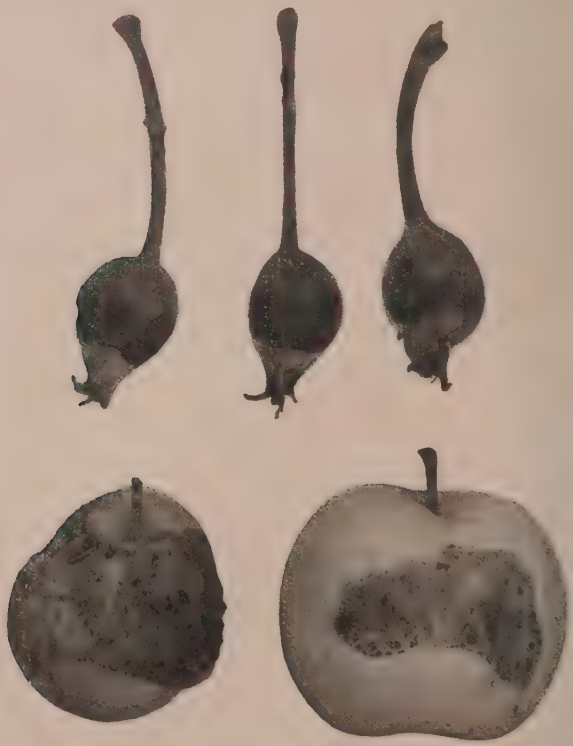


FIG. 29. Young apples (above) showing fresh scars made by gypsy moth larvae, and mature fruit (below) showing the type of blemish resulting from gypsy moth attacks. Lead arsenate applied in the early sprays will prevent such injury.

have over-wintered in the apple orchard. 2. The destruction of larvae that drift in air currents from infested woodland and settle on the apple trees. 3. The prevention of an invasion of the orchard by older larvae crawling from infested woodland.

To study the control of larvae that hatch in the apple orchard, and that drift in from infested woodland, a preliminary experiment was conducted in a block of Tolman Sweet apple trees during the spring of 1936. A supply of gypsy moth eggs was found on some white birch trees near the apple orchard. The eggs were carefully removed from the birch trees by cutting away a piece of the bark to which each egg mass was attached. Twelve egg masses were attached to the trunk and limbs of each of eight of the Tolman Sweet trees, by tacking on the pieces of bark to which the eggs adhered.

The experiment was continued in 1937, when 12 Tolman Sweet apple trees were infested with gypsy moth egg clusters.

In summarizing the conclusions from the experiments, the following points seem evident:

1. The pink spray appeared to be more effective than the pre-pink for the control of the gypsy moth.

2. Three pounds of lead arsenate per 100 gallons in the pink spray either killed the larvae outright, or checked their development, and protected the trees from material injury during the interval between the pink and the calyx applications.

3. Three pounds of lead arsenate per 100 gallons in the pink spray, followed by 6 pounds in the calyx spray, killed all of the gypsy moth larvae on the tree, and protected the tree from material injury even on heavily infested trees.

4. The gypsy moth larvae caused only slight injury, even on heavily infested trees, where 3 pounds of lead arsenate was applied in the pink, calyx, and first cover sprays.

5. Six pounds of lead arsenate per 100 gallons in the calyx spray, where the pre-pink and pink sprays were omitted, killed all of the larvae on the tree.

6. Six pounds of lead arsenate per 100 gallons in the first cover spray, where the previous sprays were omitted, killed the larvae very slowly.

7. On the trees where the pre-pink and pink sprays were omitted, the gypsy moth larvae caused distinct injury to fruit and foliage before the later sprays were applied (Fig. 29).

In 1936 the infested trees were sprayed as follows:

Tree number	Pre-Pink* May 11	Pink* May 19	Calyx* June 2
1	3 pounds lead arsenate	——	——
2	6 pounds lead arsenate	6 pounds lead arsenate	——
3	——	6 pounds lead arsenate	——
4 and 6	——	3 pounds lead arsenate	6 pounds lead arsenate
5 and 7	——	——	6 pounds lead arsenate
8	Check—no treatment		

* The quantities of lead arsenate indicated are for 100 gallons of spray. In each case 2 gallons of liquid lime sulphur were used with the arsenical.

In 1937 the infested trees were sprayed as follows:

Tree number	Pink* May 16	Calyx* June 2	First Cover* June 12
1 and 2	3 pounds lead arsenate	3 pounds lead arsenate	3 pounds lead arsenate
9 and 10	3 pounds lead arsenate	6 pounds lead arsenate	6 pounds lead arsenate
3 and 4	——	3 pounds lead arsenate	3 pounds lead arsenate
11 and 12	——	6 pounds lead arsenate	6 pounds lead arsenate
5 and 6	——	——	3 pounds lead arsenate
8	——	——	6 pounds lead arsenate
7	Check—no treatment		

* The quantities of lead arsenate indicated are for 100 gallons of spray. In each case 2 gallons of liquid lime sulphur were used with the arsenical.

The greatest influx of drifting larvae into the orchards on or near Highmoor Farm occurred during the latter part of the blooming period. Apparently, few if any larvae drifted into the orchards after the time of the calyx spray.

The Apple Fruit Fly (*Rhagoletis pomonella* Walsh). Studies are being continued to determine the proper timing of the spray applications with respect to the emergence of the flies.

Spray tests in commercial orchards showed that two applications of calcium arsenate gave very good control. Where one of the fruit fly sprays was omitted there was a distinct increase in the percentage of infested apples.

The Plum Curculio (*Conotrachelus nenuphar* Herbst). The plum curculio is a destructive pest in Maine apple orchards. The

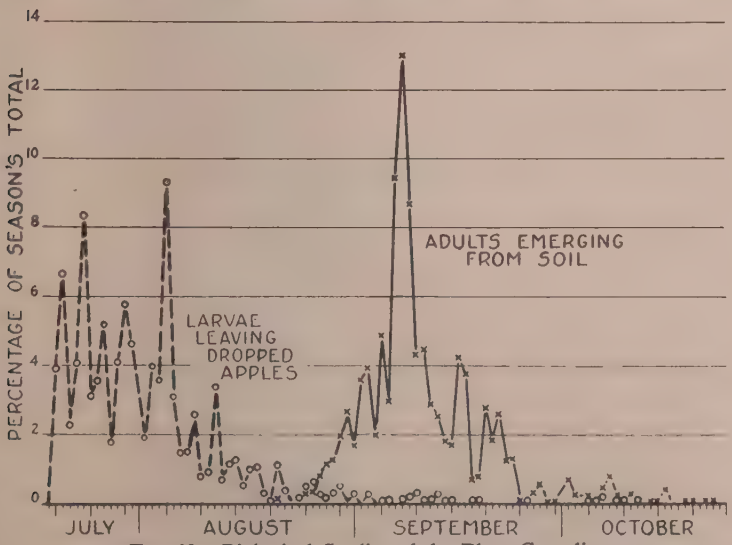


FIG. 30. Biological Studies of the Plum Curculio.

At Highmoor Farm, Monmouth, Maine, in 1936 the curculio larvae began leaving the dropped apples about July 20. Through late July and the first half of August large numbers of larvae continued to leave the fruits. After mid-August the number of larvae diminished rapidly, although small numbers continued to appear until about the middle of October.

The adult curculio beetles began to emerge from the soil about August 21. The number of beetles emerging from the soil increased rapidly to a peak that occurred on September 8. Decreasing numbers of adult curculios continued to emerge to almost the end of October. The data are based upon 2841 larvae and 3643 adults.

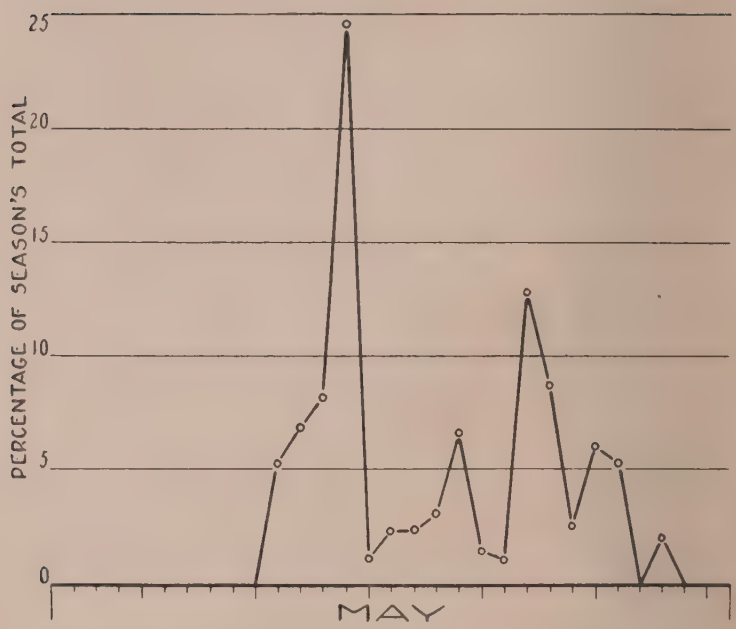


FIG. 31. The emergence of adult plum curculios from hibernation at Highmoor Farm in the spring of 1937. The entire emergence occurred during the month of May. The data are based upon the emergence of 703 adults.

young apples are scarred by the adult curculio beetles in feeding and in the egg-laying process. Many of the injured fruits soon drop from the tree. Those that remain to maturity bear unsightly blemishes.

The eggs are deposited under the skin of the apple in characteristic, crescent-shaped punctures. The eggs soon hatch, and the larvae develop in the dropped apples. The full-grown larvae leave the fruit to enter the soil. An inch or two below the surface of the soil the larvae complete their transformation to the adult beetle stage. During late summer and fall the new crop of adult curculios emerge from the soil. The curculios soon seek sheltered places along stone walls or under leaves and bushes where they spend the winter. When spring comes, the curculios emerge from hibernation to renew the attack in the apple orchard.

As a basis for improving the control of the curculio in Maine

apple orchards it is necessary to have exact data concerning the life cycle of the pest under Maine conditions.

During the summer of 1936 large numbers of apples showing oviposition scars of the plum curculio were collected at weekly intervals from neglected apple trees near Monmouth, Maine. Daily records were kept of the number of larvae that left the infested apples. Later, the number of adults emerging from the soil was recorded. The adults were placed in hibernation cages, and in the spring of 1937 the number of beetles that emerged from hibernation was recorded daily. The data recorded are shown in Figures 30 and 31.

Spray tests applied during 1936 showed that the calyx spray was the most important application for the control of curculio. It is possible that the time for most effective control may vary from year to year. The extent of variation will be determined as the study progresses.

The Apple Seed Chalcid (*Syntomaspis druparum* Boheman). The adult seed chalcid is a small, wasp-like insect. The female chalcid drives her bristle-like ovipositor into the small, developing apples, and deposits her eggs in the seeds. The chalcid larvae feed and reach their full growth within the apple seeds where they remain through the winter. In the spring, beginning about the time of application of the first cover spray, the adult seed chalcids

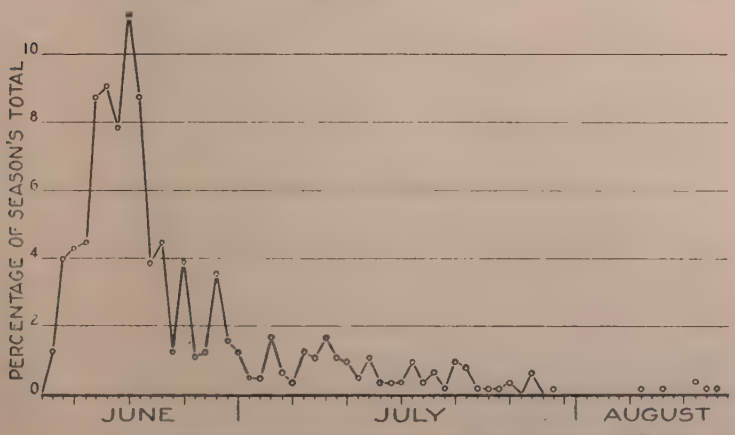


FIG. 32. Emergence of adults of the apple seed chalcid at Highmoor Farm in 1936. The chart is based upon the emergence of 363 individuals.

emerge from the apple seeds.

The injury to the fruit results from the formation of a dimple at the point where the female chalcid punctures the apple to deposit her egg. In many cases the blemish may be so small as to escape observation, but some of the fruit is distinctly malformed as a result of the attack.

Figure 32 shows the course of emergence of the adult seed chalcids at Highmoor Farm in 1936.

Spray tests indicate a reduction in seed chalcid injury as a result of the application of lead arsenate in the calyx and first cover sprays.

CANNING CROPS

SWEET CORN BREEDING. Russell M. Bailey and Iva M. Burgess. The primary objective of this project is the production and testing of varieties and hybrids to meet the canning industry's need for higher yielding, more uniform, high quality varieties. During the past year the Maine Canners' Association established a fellowship with the University whereby the services of a graduate student are made available to aid in the production of hybrid seed and to promote the breeding investigations.

Evidence of increasing interest in the use of hybrid seed is indicated by the fact that well over 40 acres were devoted in 1936 by Maine packers to the production of hybridized seed. Nearly 60 acres are planned for 1937 production. The major portion of the acreage has been used to produce top crosses between the packers' open pollinated Golden Bantam and Maine Line 100, an inbred line that has performed well in crosses in Maine. In more southern and western locations outside of Maine this inbred line has not been outstanding in performance, due to reduced vigor and susceptibility to bacterial wilt.

The performance of the Maine top crosses has been carefully studied during the last four years at Highmoor Farm and in cooperation with growers. Each year substantial increases in yield over that of open pollinated Golden Bantam have been obtained. The 1936 data were more comprehensive as, in addition to the trials conducted at Highmoor, approximately 1150 acres of top cross and open pollinated sweet corn were included in a comparative

study. The top crosses yielded on the average 20 to 25 per cent more than the packers' regular Golden Bantam strains and were slightly more uniform in maturity and ear characters. The time of maturity is slightly later than that for the packers' strains. Canning tests indicate no difference in quality. Frequent adverse criticism of plant type suggests the need for further improvement even though considerable progress appears to have been made.

New varieties and hybrids produced in other states have been under test for several years. Although some of these are promising, the majority are too late maturing for Maine. Seneca Golden, Top Cross Maine Bantam, Gemcross 39, and Surecross 39 offered the most promise at Highmoor this year for canning use and these are certainly worthy of further trial.

The study of new breeding stock and of new crosses is a part of the program that has received much attention this year. Several new crosses are worthy of careful study and some of the new inbred lines indicate improvement.

Sweet Corn Fertilization. Joseph A. Chucka and S. M. Raleigh. During 1936, experiments on sweet corn fertilization were conducted at Highmoor Farm and on five privately owned farms distributed throughout the sweet corn growing area of the State. At Highmoor some additional data were obtained on the effect of rates and methods of application of fertilizer and on the effect of lime on sweet corn yields.

As in other years broadcast applications of fertilizer were decidedly less effective than row applications in increasing sweet corn yields at Highmoor Farm. Row applications varying from 200 to 600 pounds per acre of a 5-15-5 fertilizer all showed a good return on money invested in fertilizer. Lime was again very effective in increasing yields. The highest yields were obtained on the plots which had been limed with 4000 pounds of dolomitic limestone per acre. However, the plots receiving 2000 pounds of dolomitic limestone per acre yielded nearly as much as those receiving 4000 pounds.

In our co-operative sweet corn fertilizer tests with farmers an attempt was made to get some information on fertilizer ratios, rates of application, side dressing with complete fertilizer and with nitrate of soda, and the effect of lime. In studying the effect of ratios, a 4-8-4 formula was used as a basis and the nitrogen was varied from 2 to 6 per cent, the phosphorus from 4 to 16 per cent,

and the potash from 2 to 8 per cent. Although the yields varied some among the different farms, 4-8-4 produced the highest average yield on all farms.

In studying the effect of rates of application, the following treatments were compared: 0, 300, 600, 900, and 1200 pounds of 4-8-4 applied in the row at planting time. On two farms highest yields were obtained with 900 and on the other two 1200 produced the highest yields. The average yields for the four farms were highest where 1200 pounds of 4-8-4 was used.

Side dressings with complete fertilizer applied about the 25th of July were not very effective in increasing yields of sweet corn. On the other hand, side dressings with nitrate of soda were very effective. On one low-yielding farm a side dressing of 150 pounds of nitrate of soda doubled the yield of sweet corn. The highest average yield on all farms was produced with the treatment consisting of an application of 600 pounds of 4-8-4 at planting time and followed with a side dressing of 150 pounds of nitrate of soda about July 25.

More information is needed on amounts of nitrate of soda and on time of application in connection with side dressing sweet corn. Although the early (July 25) application gave the best results last year, it is believed that a side dressing made somewhat later will give better results in the average growing season. Last year the late application (at silking time) was followed by dry weather which may account for the relatively poor results secured from the late application as compared to the early application. One may expect that the early application during a normal or wet season may induce excessive vegetative growth and delay maturity.

Lime applied at the rate of one ton per acre increased sweet corn yields somewhat on all farms, but the increase was much less than that obtained at Highmoor Farm. Perhaps the lime would have been more effective if it had been applied the previous fall instead of just before corn planting.

INVESTIGATIONS WITH BEANS. Russell M. Bailey and Iva M. Burgess. *Field Bean Planting Rate Study.* Old Fashioned Yellow Eye and the Robust pea bean were planted at several rates from two plants to twelve plants per foot to find the optimum planting rate. When considering yield, uniformity of seed size, and uniformity of pattern, about 5 seeds per foot seemed the most desirable

for the Old Fashioned Yellow Eye under the conditions grown. This corresponded to approximately 80 pounds of seed per acre.

The Robust did not react consistently to differences in planting rates thicker than the two and three per foot rates when yield was considered. There was, however, an increase in the amount of discolored seed with the wider spacing of plants.

Progress in Breeding Snap Beans. Efforts to develop a more desirable white seeded snap bean for the canning industry were continued in 1936-37. Selections have been made from the F_2 population resulting from a cross of Hercules x Conserva. Hercules is a white-seeded, green-podded bean producing a large crop of straight pods. The principal objections to this variety are to its tendency towards stringiness as the pods become older and to its lateness of maturity. A cross of Hercules with Brittle Wax was made in the greenhouse last winter and seed from the F_1 generation matured for growing an F_2 population in the field in 1937.

The Mexican Bean Beetle. John H. Hawkins. Severe injury by the Mexican bean beetle in Maine is generally confined to irregular areas scattered about in infested fields or gardens. Occasionally a whole planting of beans is destroyed by the feeding beetles and their young or larvae. The larvae are gregarious and feed close together near the place where the egg cluster was located. As the larvae grow and the foliage is destroyed, the area of infestation becomes larger. After the larvae of the first generation are full-fed, the transition from larvae to adults occurs. Observations have shown that some of the beetles fly away soon after emerging. Others stay in the same field and, when the bean foliage remains green long enough, they give rise to a second generation. The second generation matures late in the season, and the last of the larvae are destroyed by freezing weather. Most of the beetles of the second generation hibernate in or near the fields in which they develop. In the spring there is a general dispersal of the beetles which have hibernated over winter.

Investigations with insecticides for the control of the Mexican bean beetle were continued during 1936. The chief purpose was to find a practical substitute for the relatively expensive magnesium arsenate. One hundred and seventy plots were included in the experiments, each plot being 27 feet by 12 feet in size. The materials used to treat the beans were as follows: Magnesium arsenate

1 part and hydrated lime 5 parts; calcium arsenate 1 part, talc 7 parts; calcium arsenate 1 part, hydrated lime 7 parts; and calcium arsenate 1 part to 7 parts of 20-80 copper lime dust. Sprays consisting of calcium arsenate 2 pounds, hydrated lime 9 pounds, and water 100 gallons were also used. Each treatment was replicated 12 times and an untreated check plot was maintained for each treatment.

Notes on the general condition of the beans were taken at regular intervals during the summer. Beans in plots treated with calcium arsenate 1 part and 20-80 copper lime dust 7 parts were conspicuous because of their vigor and dark green color. Those treated with magnesium arsenate 1 part to 5 parts of hydrated lime were also thrifty as compared with the checks. In some cases bean plants in plots treated with calcium arsenate 1 part and talc or lime 7 parts were badly burned. In other plots treated in a like manner, no apparent burning was caused. In general, less apparent burning occurred on bean plots sprayed with calcium arsenate than where dust was used. In September the beans from treated and untreated plots were harvested, threshed separately, and weighed. A comparison of the weight of dry beans is shown in the following figure.

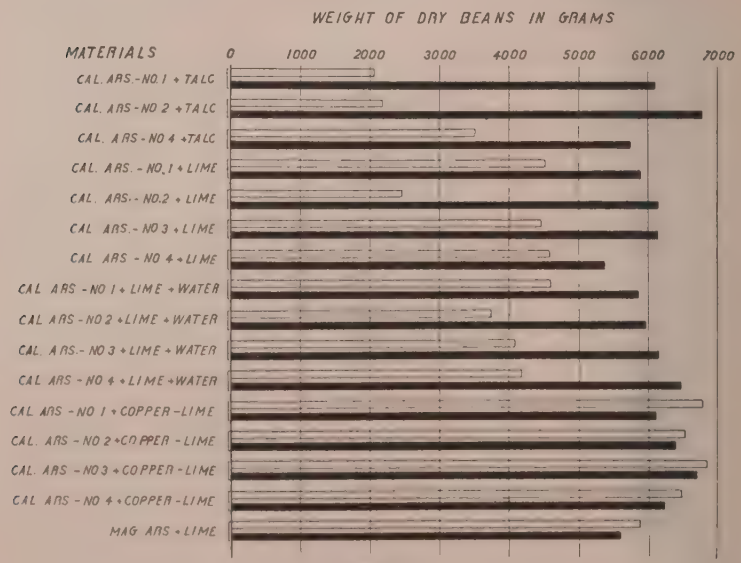


FIG. 33.

The length of lines and figures representing yields in Fig. 33 show that in general the use of calcium arsenate with talc did not result in quite as high a yield of dry beans as where the diluent for calcium arsenate was hydrated lime. This is contrary to the results obtained during the 1935 investigations. In no case where talc or hydrated lime was used were the yields as great as those obtained from the untreated check plots. On the other hand yields from plots treated with calcium arsenate and copper lime dust as a diluent were consistently greater than those from the check plots. This is also true of the plots treated with magnesium arsenate.

Although there was a slight amount of injury by the Mexican bean beetle in the untreated check plots and none in those treated with calcium arsenate and copper-lime dust, the injury done by the beetles was not great enough to account for the consistent increase in yield of beans from the treated plots. The increase may have been due to a stimulating effect on the bean plants or to the copper lime preventing certain diseases. Regardless of the cause it appears logical to consider favorably the use of copper lime dust as a carrier for calcium arsenate applied to beans for the control of the Mexican bean beetle. Data obtained during 1935 and 1936 indicate that copper lime is as effective as any diluent used with calcium arsenate for the control of the beetles and larvae. It apparently has a stimulating effect on bean plants, and dust composed of calcium arsenate and copper lime dust is cheaper than magnesium arsenate.

CHEMISTRY

Chemistry Investigation. Elmer R. Tobey and Bernie E. Plummer, Jr. The work of this department is cooperative with members of other departments in the Station and includes the chemical analyses in connection with some of the research projects. The results of these analyses are incorporated in the published reports of the respective Station research projects. For the purpose of laboratory records this work is listed under the following State Maintenance projects.

Chemical analyses in connection with the problems of nutrition and growth of poultry and dairy cattle. (In cooperation with the Department of Biology.)

At the present time about ten samples of milk from the dairy herd at Highmoor Farm are received each week for analysis. Samples of the ingredients used in making the rations for the experimental work with poultry and dairy cattle are received from time to time. Some preliminary study has been made in regard to the presence of selenium in feeding stuffs. It was called to our attention by Dr. Dove that some of the feeding oat meal, which was used in his research work, was toxic to young chicks. It was thought that the toxicity might be due to the presence of selenium in the feed as it has been known for some time that if plants grown in the semi-arid region of the Northern Great Plains section of the United Staes are eaten by man or animal certain toxic symptoms are produced. Selenium is definitely indicated as the causative agent of this toxicity by the results of research conducted by the South Dakota Experiment Station and the United States Department of Agriculture.

As the source of the feeding oat meal was traced to the Northern Great Plains section it was thought to be advisable to test the meal for the presence of selenium. After spending considerable time in developing our technic in the application of a method used by the Bureau of Chemistry and Soils, we were able to recover two parts per million of *added* selenium. We were not, however, able to detect any selenium in the feeding oat meal.

A large number of samples of feeding stuffs are received at the Station from individuals who state that animals have been made ill or have died from the effect of the feed. The samples are accompanied with request to test the feed for poison. Tests for the common poisons on these samples are usually negative. It is possible that some of these feeds contained selenium. In order to obtain some information in regard to the presence or absence of selenium in feeding stuffs shipped into this State, it is proposed to analyze several samples to determine if they contain toxic quantities of selenium.

The analysis of some of our native grains to determine the presence or absence of selenium is contemplated.

Soil analyses investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm. (In cooperation with the Department of Biology.)

During the last year the work on this project has consisted only in the analysis of the ingredients used in making the fertilizer mixtures for use on the experimental plots.

A comparison of copper fungicides as to the adherence of the copper contents to potato foliage in spraying and dusting. (In cooperation with the Department of Plant Pathology.)

One hundred sixty samples of potato foliage from the 1936 crop have been analyzed to determine the amounts of copper from different dusts and sprays which adhered to the foliage. These results are correlated with the data in regard to the control of disease as recorded in the field.

Spray residues on apples. (In cooperation with the Department of Entomology.)

During the spraying season several samples of apples from the experimental plots are received for the determination of the amounts of lead and of arsenic in the spray residue.

Miscellaneous Analyses. Under this classification is incuded the chemical work which is not directly related to any of the projects. The nature and the amount of the work varies from year to year. At the present time some preliminary work is being done in regard to the strength of mercuric chloride solutions used in the treatment of seed potatoes.

DAIRYING

An Economic Study of the Dairy Industry in Maine. George F. Dow and Andrew E. Watson. During the summer of 1936, a total of 140 milk distributors were interviewed in seven Maine market areas. Of these distributors, 26 were located in the vicinities of Farmington, Wilton, and Livermore Falls; 20 near Rumford; 15 at Skowhegan; 30 in the vicinities of Dover-Foxcroft, Dexter, and Milo; 9 at Millinocket; 13 at Old Town; and 27 at Augusta. A total of 131 of the 140 distributors were also milk producers, having dairy herds of their own to produce all or part of their milk supply. These records of milk production and distribution costs supplement those of 126 milk distributors interviewed a year earlier in the larger markets of Portland, Waterville, and Bangor.

Milk Production Costs in Herds of Producer-Distributors. A summary of the net cost of producing milk in the 131 herds of producer-distributors in seven market areas of Maine for the year ending April 30, 1936 is presented in Table 6.[4] These dairy herds averaged 17 cows per herd. Milk production per cow during the year averaged 5,922 pounds of 4.5 per cent milk, or the equivalent of 6,383 pounds of 4.0 per cent milk, which is the standard test used in this study. The total cost per hundredweight of 4.0 per cent milk was $2.60, which was reduced 34 cents by returns other than milk, making a net cost of $2.26 per hundredweight. Feed costs represented slightly over one-half of the total cost of milk production, and man labor doing chores accounted for slightly over one-third of the total cost.

TABLE 6

Summary of the Net Cost of Producing Milk in 131 Herds of Producer-Distributors During the Year Ending April 30, 1936

Item	Cost per cow	Cost per cwt. of four per cent milk	Per cent of total cost
Costs			
Feed	$ 84.22	$1.32	51
Man labor	58.76	.92	35
Use of buildings	8.18	.13	5
Use of equipment	1.29	.02	1
Cow depreciation	.78	.01	—
Herd sire	3.11	.05	2
Bedding	1.66	.03	1
Miscellaneous costs	7.66	.12	5
Total costs	$165.66	$2.60	100
Returns other than milk:			
Manure	$ 17.49	$ .28	80
Value calf at birth	2.70	.04	14
Miscellaneous returns	1.04	.02	6
Total returns	$ 21.23	$ .34	100
Net cost milk production	$144.43	$2.26	

The net cost of producing a quart of standard 4.0 per cent milk varied from 4.5 cents per quart in the Dover-Foxcroft area to 5.2 cents in the Rumford and Old Town areas (Table 7). The actual

[4] Similar information on milk production costs which were secured a year earlier for the Portland, Waterville, and Bangor areas has been published in Me. Agr. Exp. Sta. Bul. 384.

test of milk produced for distribution in these areas, however, averaged 4.5 per cent butterfat, with a range from 4.2 per cent in the Rumford and Old Town areas to 4.9 per cent in the Farmington area. The cost of producing milk of these tests, during the year ending April 30, 1936, was 5.3 to 5.4 cents per quart in each area, except that of Dover-Foxcroft where the cost was slightly under 5.0 cents per quart. The average price paid for this milk under Milk Board prices varied from 5.25 cents per quart in the Rumford area to 5.86 cents in the Old Town area. The Milk Control Board prices during the year of the study were approximately equal to the cost of milk production in the Farmington, Skowhegan, and Rumford areas for the test of milk produced. In the areas of Dover-Foxcroft, Augusta, and Old Town, the Milk Board prices slightly exceeded the cost of milk production.

TABLE 7

Comparison Between Areas of Milk Production Costs in Herds of Producer-Distributors, Year Ending April 30, 1936

Area	Number of herds	Basis of four per cent milk equiv.		Basis of actual test produced		
		Pounds milk per cow	Cost per quart milk	Butterfat test of milk	Production cost per quart	Milk Board price per quart
			(cents)		(cents)	(cents)
Dover-Foxcroft	29	6408	4.5	4.5	4.8	5.62
Farmington	24	6950	4.7	4.9	5.4	5.50
Skowhegan	15	6707	4.8	4.8	5.4	5.27
Augusta	27	6183	4.9	4.5	5.3	5.81
Rumford	19	5933	5.2	4.2	5.3	5.25
Old Town	18	6198	5.2	4.2	5.3	5.86
All areas[1]	131	6383	4.9	4.5	5.2	5.59

[1] Costs for Millinocket are not shown separately because they were based on records for only four herds, which may be too small a number to be representative of the area as a whole.

Changes have occurred in both production costs and, in some areas, in Milk Control Board milk prices. The more up-to-date costs of milk production and the prices paid dairymen for the year ending June 30, 1937, have, therefore, been presented in Table 8. The cost of producing a quart of 4.0 per cent milk during this year was 0.3 of a cent more per quart than during the previous year of the study. The production cost for 4.0 per cent milk in the areas of Dover-Foxcroft and Farmington was approximately 5.0 cents per quart, or about the same as the cost of producing milk in areas

supplying the Boston market. In Skowhegan and Augusta the cost per quart of 4.0 per cent milk was nearly 5.25 cents. In the areas of Rumford, Old Town, and Portland, the cost was 5.5 cents per quart.

The Milk Control Board prices for milk testing up to 4.0 per cent was about equal to the cost of producing 4.0 per cent milk in most of these areas for the year ending June 30, 1937, as is shown in Table 8. In most areas a premium of about one-half cent per quart was paid for milk with a butterfat content of over 4.0 per

TABLE 8

Present Costs of Producing Four Per Cent Milk in Areas Supplying Maine and the Boston Markets, and State Milk Control Board Prices, Year Ending June 30, 1937

Area	Pounds of milk per cow annually	Cost per quart of four per cent milk[1]	Milk Board price per quart of milk up to four per cent[5]
		(cents)	
Several areas supplying Boston[2]	5191	4.9	
Portland, Maine, areas:[3]			
Producers supplying larger dealers	4954	5.5	(6)
Producer-distributors	6845	5.4	(6)
Producer-distributors in other Maine markets:[4]			
Dover-Foxcroft	6408	4.8	5.25
Farmington	6950	5.0	5.00
Skowhegan	6707	5.1	(7)
Augusta	6183	5.2	(8)
Rumford	5933	5.5	5.25[9]
Old Town	6198	5.5	5.50

[1] Production costs are based on quantities of feed and labor required in the production of milk with costs adjusted for recent price trends.

[2] Formula for Boston milk costs is based on two studies, one for the year ending March 31, 1928; and the second for the year ending April 30, 1934. Both studies give an identical cost (Me. Agr. Exp. Sta. Bul. 385, p. 11).

[3] Formula for Portland producers supplying the larger dealers is based on a study for the year ending April 30, 1934; and that for producer-distributors is for the year ending April 30, 1935 (Me. Agr. Exp. Sta. Bul. 385, p. 11).

[4] Formula for producer-distributors in other Maine markets is based on a study covering the year ending April 30, 1936.

[5] Milk Board prices for milk testing over 4.0% butterfat were one-half cent a quart higher in Dover-Foxcroft, Farmington, Augusta, and Old Town areas. The milk in these areas tested an average of 4.5%, and thus should be paid for at a higher price than milk testing less than 4.0% butterfat.

[6] The price of 3.7% milk at Portland averaged 6.125 cents per quart of fluid milk and the surplus price averaged 3.53 cents per quart. If a 20% surplus were carried, the composite price would be 5.6 cents per quart; or with a 30% surplus, the composite price would be 5.3 cents per quart of 3.7% milk. For 4.0% milk, the price would be increased about one-fourth cent per quart.

[7] The price at Skowhegan was stated to be "No less than the local creamery pays for Class I milk."

[8] The price at Augusta was 5.5 cents per quart for fluid milk testing up to 4.0%, and 4.0 cents per quart for surplus milk. If a 20% surplus were carried, the composite price would be 5.2 cents per quart.

[9] The price at Rumford was 5.25 cents per quart regardless of test. The average test of milk sold was 4.0%. Effective July 1, 1937, the price was increased to 5.75 cents per quart. Dealers buying on a weight and test basis may use a fluid-surplus price system instead of paying on a flat price basis.

cent. This premium is necessary to compensate dairymen for their higher production costs if they are to continue to produce milk testing about 4.5 per cent for distribution in local markets.

Milk production per cow was one of the most important factors affecting the cost of milk production. Cows of high milk producing capacity utilize feed and labor much more efficiently than do cows of low milk production. In herds with an annual milk production of 8,000 or more pounds of milk per cow, the net cost per quart of 4.0 per cent milk was only 4.0 cents per quart (Table 9). In contrast, the net cost of production in herds with less than 5,000 pounds of milk per cow was 6.6 cents per quart, or a cost 65 per cent higher than in the herds of highest milk production.

TABLE 9

Relation of Milk Production Per Cow to the Costs of Milk Production in Herds of Producer-Distributors, Year Ending April 30, 1936

Item	Pounds of milk produced per cow annually in each herd				
	Under 5000	5000-5999	6000-6999	7000-7999	8000 or more
Number of herds	22	30	40	20	19
Average per cow:					
Cwt. milk produced	45	56	64	76	90
Cwt. grain fed	20	23	23	26	27
Cwt. hay equivalent	68	67	66	70	71
Total feed cost	$72	$79	$74	$82	$84
Cost of man labor	$61	$57	$53	$59	$73
Average per cwt. 4.0% milk:					
Pounds grain fed	44	41	36	35	30
Pounds hay equivalent	150	121	103	92	79
Total feed cost	$1.58	$1.41	$1.16	$1.09	$ .93
Cost of man labor	$1.34	$1.01	$ .83	$ .78	$ .81
Net cost per cwt. of milk	$3.07	$2.55	$2.13	$2.01	$1.86
Net cost per qt. of milk (cents)	6.6	5.5	4.6	4.3	4.0

The size of the dairy herd is another important factor affecting the efficiency of milk production. The large herds offer an especial advantage in the utilization of man labor because they permit the use of labor saving machinery, such as milking machines, to better advantage. The total annual hours of man labor per cow were 173 hours in the herds of 20 cows or more, as compared with 275 hours in the herds of less than 10 cows (Table 10). The labor requirement in the larger herds was thereby nearly 40 per cent less per

cow than in the smaller herds. The savings in the amount and cost for labor in the larger herds were partially offset by other costs, such as that of the use of equipment. The resulting effect of size of herd on the net cost of milk production was a 25 per cent saving in the larger herds, with a cost of $136 per cow in the larger herds as compared with $182 per cow in the smaller herds. Details of other factors affecting milk production costs are being prepared.

TABLE 10

Relation of Number of Cows Per Herd to the Amount of Labor and Cost of Producing Milk in Herds of Producer-Distributors, Year Ending April 30, 1936

Item	Number of cows per herd			
	Less than 10	10-14	15-19	20 or more
Number of herds	17	46	32	36
Hours of labor per cow for year:				
Milking	103	89	84	75
Washing equipment	30	26	22	17
Other chores	142	117	105	81
Total hours labor	275	232	211	173
Cost per cow for year:				
Cost of man labor	$ 81	$ 66	$ 58	$ 51
Net cost milk production	$182	$151	$142	$136

Milk Distribution Costs in Maine Markets. This study includes an analysis of distribution costs in the areas of Portland, Waterville, and Bangor for the year ending April 30, 1935; and for seven additional market areas of smaller size for the following year. Comparisons are being made for such factors as the costs of distributing raw versus pasteurized milk; the relation of sales volume per distributor and per route to costs of distribution; and comparisons between retail and wholesale milk.

A summary of income and expenses in handling milk for seven market areas for the year ending April 30, 1936, is given in Table 11. Of these 140 distributors, 131 were producer-distributors, most of whom handled a relatively small volume of sales. The average value of dairy products sold per distributor during the year was $4,931, or only $13.51 per day (Table 11). Receipts were 90 per cent from milk and 10 per cent from cream. These sales comprised 119 quarts of milk sold daily per distributor, testing 4.5 per cent

butterfat, and selling at 10.2 cents per quart. Cream sales per distributor averaged two quarts daily, selling at 66 cents per quart. Of this cream, 93 per cent was heavy cream, 2 per cent was medium, and 5 per cent was light. Retail sales comprised approximately 80 per cent of the milk and 60 per cent of the cream. The remaining proportions were sold wholesale to stores, restaurants, hotels, and other dealers.

The cost of dairy products, based on Milk Board prices, amounted to 57 cents per dollar of sales, leaving a balance of 43 cents to cover distribution expenses and net profit of the distributor. Distribution expenses amounted to $1,487 per distributor for the year, or 30 cents per dollar of sales. The net profit was $642 per distributor, or 13 cents per dollar of sales. This net profit amounted to only $1.76 daily per distributor. In addition to this net profit the distributors received wages for their own labor at the rate of $3.22 per 10-hour day for such labor as they expended in distributing milk. It should be kept in mind, however, that most of these distributors were also milk producers and thus expended only part of their time in the distribution of milk.

TABLE 11

Summary of Income and Expenses for 140 Milk Distributors in Seven Market Areas of Maine for the Year Ending April 30, 1936

Item	Average per distributor				Per cent of total sales
	Total quarts	Fat test	Value per quart	Value	
			(cents)		
Value sales of dairy products:					
Milk	43494	4.5	10.2	$4431	90
Cream	742	40.3	66.0	490	10
Miscellaneous				10	–
Total sales				$4931	100
Cost of dairy products sold:					
Milk from own herd	39325	4.5	5.6	$2199	
Milk purchased	8885	4.3	5.8	512	
Cream purchased	198	35.2	47.2	91	
Total cost				$2802	57
Gross margin				$2129	43
Distribution expenses				1487	30
Net profit				$ 642	13

The average volume of sales for the nine dealer-distributors who bought their milk supply was $11,293 as compared with $4,493

for producer-distributors. The dealer-distributors, due probably to the increase in efficiency resulting from larger volume, had a slightly lower cost of distribution per dollar of sales.

The variation between areas in the average volume of sales per distributor interviewed was not large, with the exception of Millinocket (Table 12). In Millinocket, the average annual sales per distributor was $9,868 or approximately double the average for all seven areas.[5]

TABLE 12

Comparison Between Market Areas of Income and Expenses per Dollar of Dairy Sales, Year Ending April 30, 1936

Area	Number of distributors	Value of sales per distributor	Cents per dollar of sales value for		
			Cost of milk and cream	Distribution expenses	Net profit
Old Town	13	$4291	60	32	8
Dover-Foxcroft	30	4942	60	29	11
Farmington	26	4320	58	31	11
Rumford	20	5117	56	33	11
Augusta	27	4647	56	30	14
Skowhegan	15	3819	51	35	14
Millinocket	9	9868	54	25	21
Average for all areas	140	4931	57	30	13

The amount expended as cost for dairy products (based on Milk Board prices) varied between areas from an average of 51 to 60 cents per dollar of sales (Table 12). The average expenses of distribution varied between areas from 25 to 35 cents per dollar of sales. The lowest distribution expense rate was in Millinocket where the volume of sales per distributor was the largest, and the highest rate was in Skowhegan where the volume per distributor was lowest. The net profit per dollar of sales varied from an average of 8 cents in the Old Town area to 21 cents in the Millinocket area.

The importance of volume of sales as a factor affecting the

[5] In each area an attempt was made to secure records from all distributors except the very small ones, with the exception of one large distributor at Rumford. The record for this large distributor was omitted because it was believed that it would not be typical of the others secured during the year, and thus could not be summarized without disclosing confidential information.

efficiency of milk distribution is indicated in Table 13. The distributors with the smallest volume of yearly sales had a distribution expense of 38 cents per dollar of sales as compared with 26 cents for the larger distributors. Part of this saving in the larger distributors' handling expenses was offset by a slightly higher proportionate cost for dairy products purchased (due to variations in the proportions of types of dairy products sold). The net profits of the larger distributors, nevertheless, were considerably higher per dollar of sales, averaging 16 cents as compared with 7 cents for the smaller distributors.

TABLE 13

Relation of Annual Sales per Distributor to the Income and Expenses per Dollar of Sales, Year Ending April 30, 1936

Item	Annual sales per distributor			
	Less than $3000	$3000-$4999	$5000-$6999	$7000 or more
Number of distributors	38	49	32	21
Average sales per distributor	$2462	$3875	$5873	$10424
Average cents per dollar of sales:				
Cost of milk and cream	55	57	57	58
Distribution expenses	38	34	27	26
Net profit	7	9	16	16
Total sales	100	100	100	100

A summary of distribution expenses per dealer handling raw milk is presented in Table 14. Labor was the most important item of cost, comprising 53 per cent of the total, or $762 out of a total annual cost of $1,444 per distributor. The cost for use of horses and trucks in delivering milk and cream was the next largest cost, averaging about 15 per cent of the total, or $214 per distributor. Loss from bad debts during the year amounted to $104 per dealer. This loss averaged $2.17 for each $100 of sales. Overhead costs (such as taxes, insurance, interest, depreciation, and repairs) for use of buildings and equipment was an average of $69 per plant, or 4.8 per cent of total costs. Heat, light, power, water, and refrigeration cost $91 per plant, representing 6.3 per cent of the total cost. Shrinkage and loss of milk was computed as two per cent of the milk supply received for distribution. Distribution costs were grouped as plant costs, 37.9 per cent of the total; container costs, 4.3 per cent; selling and delivery costs, 53.2 per cent; and administrative costs, 4.6 per cent.

TABLE 14

Summary of Average Distribution Costs for 139 Raw Milk Dealers, in Seven Maine Market Areas, Year Ending April 30, 1936[1]

Item of cost	Average per distributor	Per cent of total cost	Item of cost	Average per distributor	Per cent of total cost
Plant costs:			Selling costs:		
Labor	$304	21.1	Labor	$ 414	28.7
Heat, light, and power	44	3.0	Horse and truck	214	14.8
Water	5	.4	Bad debts	104	7.2
Ice and refrigeration	42	2.9	Interest on accounts receivable	9	.6
Building costs	24	1.7	Advertising	3	.2
Equipment costs	45	3.1	Misc. selling costs	24	1.7
Misc. supplies	29	2.0			
Shrinkage and milk loss	54	3.7	Total	$ 768	53.2
Total	$547	37.9	Administration costs:		
			Labor	$ 44	3.0
Container costs:			Paper and office supplies	6	.4
Bottles	$ 32	2.2	Telephone	8	.6
Cans	1	.1	Misc. costs	9	.6
Caps	29	2.0			
Total	$ 62	4.3	Total	$ 67	4.6
			Total distribution costs	$1444	100.0

[1] Costs for one dealer selling pasteurized milk were omitted in this summary.

Factors affecting these distribution costs are being analyzed for the areas summarized above and also for the Portland, Waterville, and Bangor areas which were briefly reported on in the last annual report.

Dairy Farm Organization and Management Studies. The detailed information secured in previous years for dairy farms in several important Maine areas is to be supplemented by about 400 additional records. These records are to be obtained in the vicinities of Newport and other areas not included in the previous studies. Field work on the more recent phase of this study was started early in June, 1937, as a cooperative project with the Bureau of Agricultural Economics, United States Department of Agriculture. When this field work is completed, information will be available covering dairy farm organization and management in most of the more important dairy areas in Maine. Comparisons will be made between areas; between various combinations of enterprises with dairying; between market outlets, such as milk or cream in local or Boston markets; and between other factors that cause variations in dairymen's income and expenses.

FARM CREDIT

Farm Credit in Maine. Charles H. Merchant. The Department of Agricultural Economics continued its cooperation with the Bureau of Agricultural Economics on a W.P.A. project on farm mortgages and land transfers as described in Maine Agricultural Experiment Station Bulletin 385, page 397. The field work on this project began in March, 1936, and continued until January, 1937. A total of 46,847 records on farm mortgages was obtained on the cooperative project. The Bureau of Agricultural Economics is tabulating and analyzing the material at their Chicago office.

During the summer of 1936, information was obtained from about 375 potato farmers in the principal potato growing areas of the State. About 300 records were obtained in Aroostook County and the remainder in central Maine. This information included the organization of their farms and detailed data on the use of credit. Considerable information on farm mortgage indebtedness in Aroostook County has been obtained from records at the County Court House in Houlton. This information is very helpful in supplementing the material obtained from farmers.

It is planned that further work will be carried on in Aroostook County this year. Much attention will be directed to the more important sources of farm credit in the County in view of possibly suggesting improvements in farm credit to benefit farmers and credit agencies.

FOODS AND NUTRITION

A Study of the Food Habits and the Nutritional Status of Children in Selected Communities in Maine. Mary M. Clayton. In the fall of 1936 and spring of 1937 the survey begun in 1934 was continued in Mars Hill and in Newport, a new community. It is planned to continue the study in Newport for a number of years in order to follow the growth and development of the children and to determine what improvement may be brought about in their health and nutritive condition as the result of health education in the school and instruction of the mothers through various outside agencies. For example, a preschool clinic is to be established

by the State Department of Health where mothers will receive instruction in the feeding of infants and preschool children.

In Newport physical examinations were given to 248 grade-school children during September and October by Dr. George I. Higgins, a local physician; dental examinations were made by Miss Dorothy Bryant, Director of Dental Hygiene for the State Department of Health; and fifteen measurements were made on each child by the Nutritionist. Diet records were secured for a period of one week from all children above the third grade and these same children were tested for evidence of vitamin A deficiency by the use of a new instrument called a Biophotometer.

Results of the physical and dental examinations and the diet study have not as yet been completely summarized but they show that the Newport children have physical defects very similar to those found in the other three communities. Bone defects resulting from early rickets are very common and a large number of the children have flat feet. This condition is thought to be related to rickets but is made worse by improper shoes. The teeth are somewhat better than in the other communities but an average of 8.4 cavities and 1.4 fillings per mouth was found.

As a result of our study the State Department of Health conducted a clinic at the Newport school for the purpose of advising the children with flat feet as to corrective exercises and shoes. Also those with poor posture were re-examined and correction given. A dental clinic was held for the children of the second and third grades which was financed by the State Department of Health and the local Red Cross. Prophylaxis was given by a State dental hygienist who also gave instruction on the care of the teeth to the children in all the grammar school grades. Corrective work was done by a local dentist.

In the fall 17.4 per cent of the children were found to be 10 per cent or more underweight for height and age by the Baldwin-Wood standards. In the spring the number had decreased to 14.2 per cent. The tests for vitamin A deficiency were also repeated in the spring but very little evidence was found of a lack of this vitamin as far as could be determined by the Biophotometer.

In Mars Hill the fall and spring examinations were made by the Nutritionist and diet records were secured in the spring. The

results of the examinations have not been tabulated but the diet summary shows a slight increase over last year in the use of fruits, meats, candy, and ice cream. The consumption of milk, whole grain cereals, and vegetables, other than dried beans and potatoes, remains low and that of white flour products and sweets high. The children are consuming an average of 1.85 cups of milk and half an egg a day.

It thus appears that the slight improvement in economic conditions and the educational work done last year have not resulted in much improvement in the diet of the group as a whole, even though the increased use of fruit is evident.

A Study of the Relation of Man and Animals to the Environment. W. Franklin Dove. The physical adjustment of a people to the environment depends upon five major factors:

1. Heredity of the racial stock,
2. Nature of the climate to be met,
3. Geology, soil, and plant life,
    a. Natural resources available,
    b. Soil, soil fertility, food plants,
4. Food-producing animals,
5. The economic and psycho-social influences.

Of the three chief human wants—food, shelter, and clothing—*food* forms the most direct and intimate link between all of these factors. Of all the industries and arts, agriculture—particularly food-getting—is the center of gravity about which a people must be seriously concerned if the hereditary factors for normal physical development are to be given the opportunity for full expression.

The total food-production contour of any state in the Union is now, of course, the product of the inclination of individual producers and, as a consequence, is exploited for economic gain with little or no regard for the physiological requirements of man as he must exist in the region in which he lives. Food-production has been left and continues to be left to the indefinite decision of the individual and is carried on without scientific control or suggestion, except for the occasional influence stimulated through government subsidy, bounty and royalty payments, or through the slow effect that discoveries in animal nutrition may have upon the alteration of human food habits—habits which are stubbornly rooted in the past.

In order to evolve a food-production program for the State, based upon a physiological basis, we have used two methods of analysis. In the first place, a statistical study of all factors which make up the foregoing linkage of climate-soil-plant-animal-man, has produced certain indices of welfare from which it is not only possible to detect the degree to which the State food-production contour deviates from the normal but also to find a definite indication of the form that both research and production should take if they would provide a remedy for the deficiencies arising from nutritional maladjustment of man to this particular environment.

The integration of all factors, of the environment and of the inhabitants concerned, into one object of study represents a *generalized* form of research and as such represents only one of the two ways in which the writer has attempted to analyze this biological problem. The second method of analysis is *specific* and is established through a study of the nutritive instincts, food preferences, and food habits of experimental animals held under the controlled conditions necessary to an experimental program. In this experimental study we are given the opportunity to apply all five factors of the linkage, from climate to economics, to a rigorous experimental laboratory technic. From these two legitimate methods of analysis, the general and the specific, the food-production program and possibly the entire economic and social program of a society may be observed, perhaps guided. An experimental technic insures that *fact,* not fancy, indicates the direction of true progress.[6]

In the beginning of this study there were revealed many discrepancies between the actual food-production of the State and the food production that would be required to meet physiological requirements. For example, the welfare indices indicated that one evidence of widespread maladjustment was a high incidence of tooth, bone, and structural defects, associated with a food-production program low in the protective foods—milk, eggs, fruits, and certain vegetables—with climatic and soil factors to augment the deficiencies.

Presented herewith is a partial statement of the evidence for a high incidence of defective teeth.

---

[6] This biological study of wants, as applied to society as a whole, will be treated elsewhere.

Evidence for the High Incidence of Defective Teeth:

1. Maine drafted men stood fifth highest in the Union in the number of men with defective teeth—35.97 per 1000.[7]
2. Of the men students born in Maine entering the University of Maine in 1933,
   10.22 per cent had carious teeth, and
   50.32 per cent had one or more teeth missing.[8] [9]

It is generally recognized that carious and defective teeth are at least related to a deficiency of protective foods, especially those which supply vitamins C and D and the minerals calcium and phosphorus. The tendency of the medical profession to rely upon the use of the concentrate and specific vitamins or minerals for nutritional deficiency diseases is the prerogative and sometimes the necessity of the profession. It should be recognized, however, that the ultimate goal should be for a food-production program which will preclude the necessity for the "medicinal" concentrates. The writer believes, as he has stated previously, "that considerable progress toward a permanent cure for these conditions lies in a large measure in the production of agricultural crops and food products containing their normally allotted quota of food products."[11]

Theoretically, there exists an adequate supply of the minerals calcium and phosphorus in milk and in the correct assortment of vegetables and fruits. As for vitamin C, however, the State of Maine fails to produce citrus fruits. Therefore, the development

---

[7] Dove, W. Franklin, 1934. "A study of the causes of nutritional deficiency diseases in the livestock and inhabitants of Maine with possible corrective methods secured from the production of superior foods." Me. Agr. Exp. Sta. Bul. 375. p. 208.

[8] Additional evidence of a high incidence of teeth defects has recently been reported by Miss Clayton in a study of the nutritional status of children in three selected communities of the State, "the most outstanding defect noted was dental caries." In the fall there was an average of 12 cavities per mouth. Only one child had a perfect set of teeth.[10]

[9] Dove, W. Franklin, 1935. "A study of individuality in the nutritive instincts and of the causes and effects of variations in the selection of food." *American Naturalist,* 69:524.

[10] Clayton, Mary M., 1936. "A study of the food habits and the nutritional status of children in selected communities in Maine." Me. Agr. Exp. Sta. Bul. 384. p. 398.

[11] Me. Agr. Exp. Sta. Bul. 375. p. 267. 1934.

of strains or varieties of fruits and vegetables high in ascorbic acid and suitable to this climate has come to be an important phase of the experimental program. The "vitamin sieve" is applied to selection and propagation work. Common fruits and vegetables under active experimentation include the following: tomatoes, rutabagas, cucumbers, onions, apples, and strawberries. Varieties which prove acceptable for vitamin content will then be tested, as usual, for hardiness, adaptability, consumer preference, and so on.

In the attempt to secure natural supplies of all food-nutrients required for the formation of sound teeth and for the prevention of bone and structural defects, the greatest difficulty is encountered in securing natural supplies of vitamin D, since only a negligible quantity of this anti-rachitic factor is present in grains, fruits, vegetables, and ordinary meats. For that reason, considerable experimentation has been carried on in order to discover new reliable sources of natural foods containing enough vitamin D to supply the growing individual with a protective level of vitamin when the particular food is consumed in the amounts normally desired. The problem, of course, differs from the usual one of bio-assay, because, in adapting nutritional science to man, we are concerned with many complicating factors not encountered in assays based upon the chemical, the physical, or the animal measuring-rule. In the adaptation of nutritional science to man, we are met with many factors which, at times, so modify the results of bio-assay as to negate their direct application to man. The science of *human* nutrition must, in addition to the quantitative and qualitative assays, consider the effects which arise from the innate desire to *select foods*. It has been discovered in this laboratory that the results from feeding an animal a mixture of foods are quite different from the results which occur when the same foods and the same quantities of foods are fed separately. The entrance of the one factor—selection—has an exceedingly important biological significance for human nutrition.

Even though the factor food-selection may be of less importance to animal than to human nutrition, nevertheless most experimental animals and most of the domesticated animals are addicted to and thrive upon a certain freedom in choice of food. Furthermore, the results of the analysis of freedom of choice in experimental animals may throw light upon the same phenomenon as it appears in man, in the same manner that the principles of heredity

and bacteriology, first evolved as experiments with animals and plants, have been used to predict the mechanism of heredity and disease resistance in the human being.

In the food selection studies, only seven different food choices have been made available to the experimental animals. Each food has supplied some positive nutritional factor. Many new foods have been tried until the best combination of foods was discovered. Out of a large number of different foods tested, two foods have been found which will permit normal growth and development in a sunless laboratory. These two foods are Whole Egg and Maine White Fish. Superior individuals,[12] those which grow at a rate between the mean and the maximum, choose to consume 10 per cent of their daily food as whole egg or 6 per cent as white fish. In so choosing they are able to develop in size and bone equally well with those fed the vitamin concentrate, cod-liver oil. Meat or milk will not take the place either of egg or white fish.

Thus it appears to be nutritionally possible to secure from natural and available food sources of the State those vitamins, C and D, and those minerals, calcium and phosphorus, which are necessary for the formation of sound teeth and body. All of these foods—fruits, vegetables, and protein-foods—are products of the State.

GARDEN CROPS

Cultural and Breeding Studies. Russell M. Bailey and Iva M. Burgess. *Variety Tests.* Some of the newer vegetable varieties of note were Louisiana Copenhagen cabbage, an early compact heading variety, bursting quickly if allowed to stand too long before cutting; Danish Glory cauliflower with compact white heads; Colorado and Straight 8 cucumbers with slender smooth dark green fruit; Harlem Market spinach with dark savoyed leaves and slow to bolt to seed; and Banquet squash similar to Buttercup with a yellow skin. Results obtained from the variety tests have been published as Miscellaneous Publication No. 553, 1936, "Vegetable Variety Trials at Highmoor Farm, Monmouth, Maine."

Lettuce. Thirty-three stocks of lettuce of New York type

[12] In these experiments both chicks and rats are used as experimental animals. In this particular experiment, only chicks were used.

were under observation during the season. Growth was on the whole not particularly good, due partially to the dryness of the season. Planting was timed to bring the crop to maturity during the warmer part of the season. Little trouble was experienced from tipburn but there was a severe loss from "yellows." Number 515 and "B" were among the better heading kinds. Imperial 152 and Imperial 615 produced some heads of fine quality. In previous trials, however, the Imperials have been quite susceptible to tipburn.

Hay Mulch on Lettuce. In contrast to the results of two previous seasons the crop of lettuce from plots receiving hay mulch was inferior to that from plots without it. Maturity was considerably retarded and the percentage of plants heading was much less than on the check plots.

Tomato Breeding. F_2 and back crossed plants of Pritchard and Shirley Bonny Best crossed with a crack-resistant selection were under observation for the selection of early smooth fruited plants which appeared somewhat resistant to cracking. The progeny of numerous promising plants are being grown in the 1937 season for further selection.

For several years it was noted that the F_1 hybrids were more prolific than were either of the parents. Over a period of three years there was an average increase of 28 per cent in the early yield of marketable fruit from the hybrids as compared with the best yielding variety in the plots. In 1936 samples of seed were sent to growers to test the performance of this hybrid material under different conditions. Most growers obtained favorable results.

CUCUMBER BREEDING FOR RESISTANCE TO SCAB. (*Cladosporium cucumerinum*). Russell M. Bailey and Iva M. Burgess. This work has been continued and new varieties tested for resistance but none were found to be as resistant as our present stock. Two homozygous resistant selections were tested cooperatively in 1936 with approximately 30 growers scattered throughout the State. Returned questionnaires indicate that the selections held their resistance in all locations where the test was conducted and that they are of promise for home use where scab is serious. Some improvement in type appears necessary to suit the demands of the commercial growers.

BORON DEFICIENCY IN CAULIFLOWER AND RELATED PLANTS. Frederick B. Chandler, Joseph A. Chucka, and Irvin C. Mason.

Through greenhouse experiments the boron deficiency symptoms have been produced in cauliflower, Brussel sprouts, kohlrabi, kale, and broccoli. The symptoms are not the same for all crops in this group of plants and the symptoms in the field may vary slightly from those in the greenhouse. Up to this time cauliflower and rutabaga are the only plants which have shown the deficiency in the field. The affected cauliflower has a small head with brown spots while the rutabaga has a watery or brown center. In the greenhouse as well as in the field only small quantities of boron are necessary to prevent this disease.

Greenhouse and field experiments are now being conducted to study row *vs.* broadcast applications, delayed applications, and the time that boron is most important in the development of the plant.

Fig. 34. The above cauliflower were grown in the greenhouse under controlled conditions. The plant on the left received no boron during the latter part of its life. This plant produced an unmarketable head and it was very small and brown. The plant on the right received boron and produced a good head.

Control of the Striped Cucumber Beetle. John H. Hawkins. Preliminary investigations in the control of the striped cucumber beetle, *Diabrotica vittata*, were made previous to 1936. These investigations consisted largely of the trial of recommended insecticidal materials but the trials also included some new combi-

nations of materials. The standard recommendation of gypsum as a carrier for calcium arsenate for the control of the striped cucumber beetle did not prove entirely satisfactory under Maine climatic conditions, the gypsum sometimes becoming lumpy and hard to mix. On the other hand, talc when combined with calcium arsenate provided an excellent dust and gave promise of being equally as effective as gypsum when used for this purpose. During 1936 further tests of talc were conducted and because of its fungicidal value copper lime dust was also investigated as a carrier for calcium arsenate.

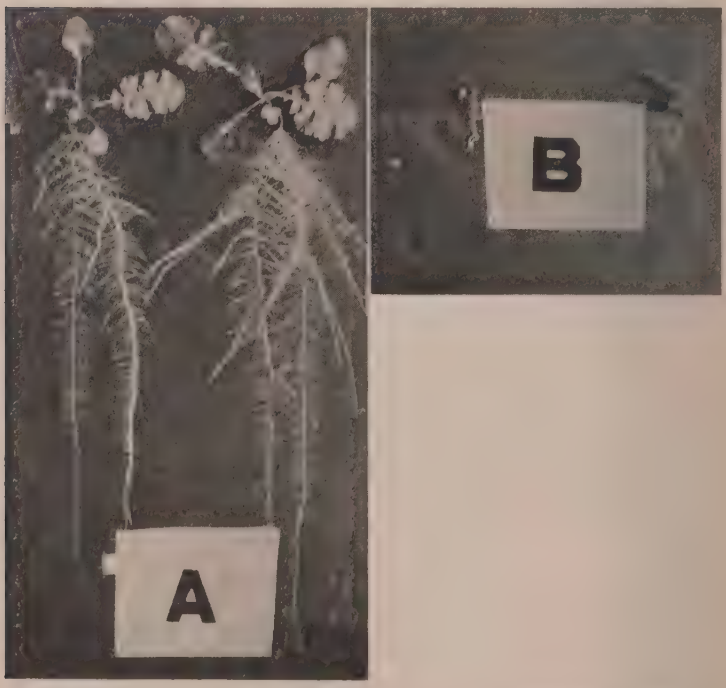


FIG. 35. The rutabagas pictured here are all seventeen days old and were taken from the same uniform lot of seedlings. The two plants marked A were supplied with a solution containing .3 of a part per million of boron. The two plants marked B received no boron but all other nutrients were the same. Both pictures are about one-fourth actual size.

Plots were laid out with six hills of cucumbers to a plot, and the dusts were applied to the cucumber seedlings soon after they came through the soil. The plants were then dusted often enough so that they were protected from the beetles until the cucumbers began to set on the vines. There were twelve replications for each material used and a check plot was maintained for every treated plot. Weights of cucumbers picked from the plots are shown in the following table.

TABLE 15

Cucumber Dusting Experiments 1936

Treatment	Weight of cucumbers in pounds		Increase due to treatment	
	Treatment	Check	Pounds	Per cent
Calcium arsenate 1 — Talc 15	448.3	298.2	151.0	33
Calcium arsenate 1 — Talc 20	504.1	263.6	263.6	52
Calcium arsenate + Copper lime	456.7	265.8	190.9	42
Calcium arsenate 1 — Gypsum 15	395.5	264.3	131.2	33
Calcium arsenate 1 — Gypsum 20	470.6	283.6	187.0	40
Totals	2275.2	1375.5	922.7	
Average				40

Cucumbers were picked and weighed from all the plots at weekly intervals. Yields from the treated plots as a whole, regardless of treatment, averaged 40 per cent more than the average yield from the untreated check plots. The greatest increase in yield was obtained from the plots treated with calcium arsenate 1 part and talc 20 parts, the increase being in this case 52 per cent. The use of calcium arsenate, 1 part to 10 parts of a 20-20 copper lime dust, resulted in an increase in yield of 42 per cent. The yields from plots dusted with 1 part of calcium arsenate to 20 parts of gypsum were 40 per cent greater than from check plots. The plots dusted with 1 part of calcium arsenate to 15 parts of gypsum, and also the plots dusted with 1 part of calcium arsenate to 15 parts of talc, showed an increase in yield of 33 per cent over the checks.

Data obtained from 1936 experiments indicate that a dust composed of 20 parts of talc to 1 part of calcium arsenate is satisfactory for controlling the striped cucumber beetle. It would probably be advisable for those who desire to use talc as a diluent for calcium arsenate to secure a supply early in the season, for at

present it is not stocked by most local insecticide dealers. It can be obtained from a number of sources, however, and is relatively inexpensive. Talc, to be effective as a diluent for insecticides, should be fine enough so that it will pass through a sieve containing 300 or more meshes per linear inch.

Probably most cucumber growers, especially market gardeners or pickle growers, could use copper-lime dust to advantage as a carrier for calcium arsenate. Since some are already using the copper-lime dust alone, the addition of the calcium arsenate would involve little additional labor in preparing materials for application.

GRASSLAND MANAGEMENT

PASTURE IMPROVEMENT. D. S. Fink. The importance of a liberal application of complete fertilizer as the initial step in permanent pasture improvement was emphasized in Bulletin No. 384. This information was obtained from fertility test plots harvested during the seasons of 1935 and 1936. These plots were again fertilized this spring and are being harvested. The object now is to determine the amount of fertilizer necessary to raise the level of soil fertility to that found in excellent farm pastures shown in Table 16, together with the cost involved to arrive at this level.

TABLE 16

A Preliminary Survey of Several Hundred Acres of Farm Pastures Showing the Pounds of Available Plant Food Present at Various Levels of Production[1]

Pasture rating	Per cent vegetation			pH of Soil	Available Plant Food[2]				
	White clover	Grass	Weeds and bare ground		K	Ca	P	Mg	NO_3
Poor pastures	5	37	59	5.33	50 −	1000—	0+	10+	0
Medium good pastures	21	58	21	5.66	50 +	1000+	25—	25—	6
Good pastures	36	53	8	5.69	100 −	1000+	25	25—	20
Excellent pastures	53	45	0.9	5.84	150	2000	25+	25	60

[1] Soil samples taken during August, 1936.
[2] Available plant food determined by Maine Soil Testing Service methods.

At Highmoor Farm every attempt is being made to keep the dairy herd on excellent pasture throughout the growing season. To date, the cows have had all the excellent pasture they could eat.

During the early part of the grazing period they were on the differently fertilized permanent pasture paddocks. From the permanent pastures they went onto Ladino clover and from there onto oats which was seeded down to a hay mixture. From the oats they went onto perennial rye grass which was also seeded down to a hay mixture and from the rye grass onto Sudan grass. From the Sudan grass they will go back to the Ladino clover and the permanent pasture paddocks. Shortly, information will be available on the costs and the suitability of the various types of pasture grasses and legumes, as well as fertilizer treatments used.

HOUSEHOLD EQUIPMENT

The Economical Management of Kerosene Cook Stoves to Secure Palatability of Product in Maine Farm Households. Merna M. Monroe and Pearl S. Greene. Five kerosene stoves are being studied in this project. Four of these stoves have built-in ovens. Two of the ranges have the long-chimney, wick burners; two have the short-chimney, wick burners; and one has the short-chimney, wickless burners.

To date, tests have been made to determine the effect of the diameter of pans and of black-bottom surfaces on aluminum pans upon the time and efficiency of heating a kilogram of water. Tests have been made to determine the rate of evaporation of boiling water when the burners were operated on high and on low heat. This latter procedure is helpful in estimating the flexibility of the burners for fast and for slow cooking and in judging the amount of water needed for top-stove cooking. Tests have been made to ascertain the time and the kerosene consumption required to heat the ovens to each of four baking temperatures. Records were taken of the amount of kerosene required to maintain the empty ovens at each of these four temperatures. The reliability of the oven heat indicators was noted. To test the heat capacity of the ovens, six pans, each containing a kilogram of water at 20° C., were staggered on the two racks. Evenness of heat distribution was tested by baking refrigerator cookies. The six small sheets were staggered on the two baking racks. Further work is needed before conclusions can be given in regard to oven cooking.

The data obtained so far lead to the conclusions which follow.

Slight changes in diameter of fairly wide pans do not noticeably affect the thermal efficiency of heating a kilogram of water from 20° to 90° C. when used on any of the kerosene burners. A small pan, 5⅝ inches in diameter, was noticeably less efficient than a pan 7⅝ inches wide; approximately two minutes more time was required with the former.

A black-bottom, aluminum pan was approximately 10 per cent more efficient than the satin-finish aluminum pan when used to heat a kilogram of water on the long-chimney, wick burners. On the short-chimney, wick burners and on the wickless burners, the black-bottom pan was nearly 20 per cent more efficient under the same circumstances. During maintained boiling on low heat of the long-chimney burners, approximately the same amount of water was evaporated in the black-bottom pan as in the satin-finish one. But on the short-chimney, wick and the wickless burners, approximately one-fourth cup more of water per 30 minutes was evaporated from the black-bottom pan than from the pan with a satin-finish bottom. Since these burners cannot be turned to a lower heat, the gain in efficiency through using black-bottom aluminum pans cannot be realized during maintained boiling. On the contrary, one will be obliged to use a little more water in the black-bottom pans than in aluminum pans with satin-finish bottoms to compensate for the evaporation of additional water.

The speed of the burners, when beginning with a cold start, seems to depend upon the design adopted by individual manufacturers rather than upon the type of burner. The short-chimney, wick and the wickless burners require a few minutes of warming before the burners can be permanently regulated. Nearly four minutes time can be saved in heating a kilogram of water if these short chimney burners have received the preliminary attention and have operated a total of five minutes before putting the test pan in place.

To heat a kilogram of water from 20° to 90° C., the short-chimney, wick and the wickless burners gave efficiencies of approximately 30 per cent; whereas, the long-chimney burners were approximately 20 per cent efficient in heating water. During maintained boiling on low heat, the efficiency, or the ratio of heat lost through evaporation to the heat input, was approximately 16 per

cent for the long-chimney burners and 24 per cent for the short-chimney, wick burners. However, to maintain boiling of a cooking process for one-half hour on low heat, all types of burners required approximately the same amount of kerosene. The most efficient burners eventually lose just as much heat into the room as do the less efficient ones. With the former, more water is changed to steam and forced out into the room, and with the latter more heat escapes from the burner into the room. The increased efficiencies obtained in measuring the ratio of heat output through evaporation of water to the heat input from the burner does not give the true picture of cooking conditions. For certain types of cooking, a slow rate of heat input is necessary.

The rough approximations of the amount of water evaporated during thirty minutes of maintained boiling can serve as a guide only. The width and condition of the pan affect the amount of heat received, to some extent, but the largest variable in these tests was the setting of the burner each time it was used. Approximately two and one-half cups of water were evaporated in thirty minutes of boiling with high heat of the long-chimney burners, and slightly less than one cup when these burners were operated on a low, blue flame. A lower heat can be obtained from these burners by turning the wick down until a yellow flame results, but operating at this very low heat chars the wick badly. The short-chimney, wick burners evaporated boiling water at the rate of approximately two and one-half cups per thirty minutes on high heat and nearly one and one-half cups on low heat. The wickless burner operated on high heat evaporated about three cups of water in thirty minutes and one and one-half cups on low heat.

The four ovens varied in size and construction. They also varied greatly in the time required to preheat them, and differed in the amount of kerosene needed to maintain a given temperature. However, the amount of kerosene required per cubic foot in each of the ovens differed little, except that the insulatd oven with the wickless burners required less kerosene than the others.

The oven with the wickless burners was overheated. To maintain low baking temperatures it was necessary to open a wide vent, and perhaps use but one burner. The use of only one burner resulted in uneven distribution of heat. The baffle in this oven formed about two-thirds of the bottom wall and was at a higher

level than the bottom opening for the door. The heat arising between the front of the baffle and the open door of the preheated oven made it very uncomfortable to admit, rearrange, or remove pans. With loads of low thermal capacity, it was necessary to use only one burner to prevent overheating.

The oven which was heated by the short-chimney, wick burners had no baffle at the bottom. The bottom wall was built without holes for circulation of air from the burners. The front of this oven was decidedly hotter than the rest of the air space. This uneven distribution of heat was particularly noticeable when the rack was in the bottom groove. There was not enough flexibility in the range of temperatures maintained in this oven with small and large loads. It was difficult to maintain low baking temperatures for low-thermal-capacity loads, and somewhat difficult to attain higher temperatures for high-thermal-capacity loads.

The two ovens heated by long-chimney burners were built with baffles and provision was made for the circulation of air from the burners. These ovens had a fairly even distribution of heat. The larger oven, which had the slower burners, may be overloaded in certain circumstances. If a large, high-thermal-capacity load is put into this preheated oven, the slow burners may not be able to bring the oven back to baking temperature until time for the load to be removed from the oven.

Only one of the four ovens had reliable oven heat indicators. Two ovens had an indicator built in the door; these were not reliable. The other two ovens were equipped with the bimetallic expansion indicator. One of these indicators was reasonably accurate and the other was of no value.

THE EFFECT OF THE METHOD OF HEAT APPLICATION, AND ACCOMPANYING OVEN CONDITIONS, UPON FLAVOR AND TEXTURE OF BAKED FOODS. Merna M. Monroe and Pearl S. Greene. The object of this project is to determine whether the method of heat application produces any difference in baked foods, to determine the effect of excessive evaporation of water within the oven, and to ascertain differences in oven temperatures suitable for baking specific foods under different oven conditions.

Water-heating tests have been made with a heat-resistant glass and a tinned pan. With small quantities of water, the low thermal capacity of the tinned pan permits faster heating from a cold start

than does the glass pan which has a high thermal capacity. With larger quantities of water, the glass is a little slow at the beginning, but permits the water to reach 90° C. sooner than does the tinned pan. Once the water is hot, evaporation takes place at a faster rate in the glass pan than in the tinned one. This faster evaporation in the glass is explained by the fact that it absorbs more of the radiant energy in the oven than does the bright tin.

Cooking tests made with steam at 100° C. introduced into the oven resulted in more browning of certain foods and with the use of less electrical energy than when no steam was added. Use of an uncovered pan of water in the oven during the baking of muffins resulted in the use of more electrical energy and in over-browning of the bottom of the muffins. These tests are being made in a large, well-insulated, high-thermal-capacity oven. Tests have not yet been made to ascertain the effect of over-loading the oven. In the household, the addition of uncovered pans of water may lead to over-loading the heat capacity of the ovens. It is hoped that the data obtained in this project will lead to useful conclusions concerning the loading of household ovens.

INSPECTION SERVICE

Work of Inspection Service. Elmer R. Tobey, C. Harry White, Bernie E. Plummer, Jr., Glenn H. Perkins, Millard G. Moore, and George P. Steinbauer. The Commissioner of Agriculture is the executive of the laws regulating the sale of fertilizers, agricultural seeds, insecticides, fungicides, foods, drugs, and feeding stuffs in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to analyze or cause to be analyzed the samples collected by the Commissioner and to publish the results of the analyses together with the names of the persons from whom the samples were obtained and such additional information as may seem advisable. This information is reported in the Official Inspections bulletins published during the year. The State Tax Assessor is the executive of the laws regulating the sale of gasoline and motor lubricants. It is the duty of the Director of the Station to analyze or cause to be analyzed the samples collected by the State Tax Assessor but no provision has been made for the publication of the results of the analyses.

In addition to the inspection service the department is requested frequently to make analyses of various types of materials for individuals. These unofficial samples include milk, cream, vinegar, miscellaneous substances, and materials suspected of containing poison. The results of the analyses on these samples are not published but are reported to the individuals who submit the samples.

A brief summary of the work of inspection is as follows:

Testing of Dairy Glassware. It is required by law that all Babcock glassware used in Maine by creameries, ice cream factories or others buying or selling milk or cream on a basis of the butterfat content must be tested for accuracy at the Maine Agricultural Experiment Station. Two thousand three hundred forty-six pieces were examined during the year ending June 30, 1937, and two thousand three hundred forty-four of this number were passed.

Fertilizer Inspection. Four hundred ninety-eight samples of fertilizer materials were collected and analyzed. Three hundred fifty-eight of these samples are mixed fertilizers containing nitrogen, phosphoric acid, potash, and in some of the samples, magnesium. The samples of mixed fertilizers represent two hundred twenty-two different brands. The results of the analyses are reported in Official Inspections 161.

Agricultural Seeds, Insecticides and Fungicides Inspection. Ninety-nine official samples of seeds and fifty-six official samples of insecticidal and fungicidal materials were collected and analyzed. The results of the analyses are reported in Official Inspections 162.

Food and Drug Inspection. The number and variety of samples collected and submitted depend upon the nature of the inspection work carried on by the Division of Inspection, Augusta, Maine, in the enforcement of the food and drug laws. A large amount of this inspection work does not require the collection or analysis of samples. Two hundred six samples of butter, Hamburg steak, ice cream, maple syrup, oil used in packing sardines, vinegar, spirit of camphor, headache powders, diluted hydrochloric acid and sweet spirit of nitre were examined and the results of the analyses are reported in Official Inspections 163 which is in the process of publication.

Feeding Stuffs Inspection. Nine hundred ninety-nine samples of feeding stuffs were received and the percentages of protein, fat, and fiber in these samples were determined. The results of the analyses will be published in Official Inspections 164.

Gasoline Inspection. One hundred ninety-three samples of gasoline were received. The results of the analyses indicate that eight of these samples were found to require a higher temperature for complete distillation than the maximum temperature (437° F.) specified in the Maine law regulating the sale of motor gasoline.

Motor Lubricants Inspection. Seven of the eighty samples of motor oils which were examined failed to meet the specifications asked for by the inspector for the respective brands. In practically every instance it appeared to be a case of substitution by the salesman.

LAND USE

LAND USE STUDIES IN MAINE. Charles H. Merchant and Andrew E. Watson. This study was begun about a year ago in cooperation with the Biology Department of the Maine Agricultural Experiment Station. The major phases of the project may be classified as follows:

1. Classification of the soils in the State (to be conducted by the Biology Department).
2. Land cover—Cover on the land and the physical and economic factors responsible for the present status (to be conducted by the Agricultural Economics Department).
3. Classification of land resources with recommendation for future use (to be conducted by the Agricultural Economics Department).

During the past year the soil mapping was begun in York County. As the project is planned, the field work on the economic phases of the study will be delayed until soil maps have been prepared for at least a considerable portion of one county.

Several maps have been prepared by the Department of Agricultural Economics for the two southern-most counties of the State showing per cent slope of land, land contours, water sheds, roads and other similar information. As indicated in the last report of progress, Bulletin 384, considerable other information is available which should be helpful in this project.

SOIL SURVEY. Joseph A. Chucka, Delmar B. Lovejoy, and John R. Arno in cooperation with Kenneth V. Goodman, of Soil Survey Division of the United States Bureau of Chemistry and

Soils. This work is being done by the Maine Agricultural Experiment Station in cooperation with the Soil Survey Division of the United States Bureau of Chemistry and Soils. Briefly the survey consists of: First, classification of soils into definite soil types; second, plotting of these soil types on a soils map; third, description of the physical and chemical characteristics of each soil type; and fourth, any additional information about the soil types which will help to determine their comparative value for agricultural, or other purposes.

The survey will serve as an accurate inventory of the soil resources of the State and will be of great value to all who are interested in or dependent upon the agricultural welfare of Maine. The survey maps show in addition the complete road and drainage system of each county as well as such cultural features as houses, churches, schools, cities, and towns. Maps and reports of the survey will be published by counties. At present the work is in progress in York County. Approximately 300 square miles have been covered during the past year.

POTATOES

AN ECONOMIC STUDY OF THE POTATO INDUSTRY IN MAINE. William E. Schrumpf. Included under this general heading are reports on costs and returns in producing potatoes in Aroostook County, Maine; costs and returns in producing potatoes in central Maine with comparisons; and farm organization of potato farms in Aroostook County in 1935 compared with 1928-30.

COSTS AND RETURNS IN PRODUCING POTATOES IN AROOSTOOK COUNTY, MAINE. This study which was briefly reported in Maine Agricultural Experiment Station Bulletin 384 is completed in manuscript form but is not yet available for distribution.

COSTS AND RETURNS IN PRODUCING POTATOES IN CENTRAL MAINE WITH COMPARISONS. The cost of producing potatoes in central Maine, including growing, harvesting, storing, and selling, averaged $160.62 per acre. In comparison the production cost on farms in the Presque Isle area averaged $177.84 per acre. On the central Maine farms 68.6 per cent of the total production cost was for growing, 10.5 per cent for harvesting, 15.7 per cent for storing, and 5.2 per cent for selling. Compared with the Presque Isle farms,

the central Maine farms had a larger proportion of the production cost for growing and a smaller proportion for storing (Table 17).

TABLE 17

Costs of Growing, Harvesting, Storing, and Selling Potatoes on Potato Farms in Central Maine Compared with Presque Isle, Average of the Two Years, 1929-1930

Item	Cost per acre		Proportion of cost	
	Central Maine	Presque Isle	Central Maine	Presque Isle
	dollars	dollars	per cent	per cent
Growing	110.28	107.41	68.6	60.4
Harvesting	16.85	19.19	10.5	10.8
Storing	25.20	38.69	15.7	21.7
Selling	8.29	12.55	5.2	7.1
Total	160.62	177.84	100.0	100.0

TABLE 18

Costs of Growing Potatoes on Potato Farms in Central Maine Compared with Presque Isle, Average of the Two Years, 1929-1930

Item	Average per acre				Proportion of cost	
	Central Maine		Presque Isle			
	Amount	Cost	Amount	Cost	Central Maine	Presque Isle
		dollars		dollars	per cent	per cent
Man labor	44.6 hr.	14.66	37.0 hr.	14.20	13.3	13.2
Horse labor	53.3 hr.	12.26	45.8 hr.	11.52	11.1	10.7
Tractor use	3.2 hr.	3.31	2.2 hr.	3.06	3.0	2.9
Truck use	.9 hr.	.72	.5 hr.	.56	.7	.5
Automobile use		1.15		1.00	1.0	.9
Equipment use		5.10		4.24	4.6	4.0
Total labor, etc.		37.20		34.58	33.7	32.2
Seed	6.5 bbl.	14.21	6.6 bbl.	15.44	12.9	14.4
Seed treatment material		.22		.16	.2	.1
Fertilizer	1.01 T	43.71	.92 T	40.28	39.6	37.5
Barnyard manure	2.00 T	5.38	1.08 T	3.39	4.9	3.2
Green manure crops	.01 A	.06	.04 A	.23	.1	.2
Spray and dust		5.54		3.72	5.0	3.5
Land use		2.50		8.26	2.3	7.7
Interest on growing costs		1.06		1.00	.9	.9
Other costs		.40		.35	.4	.3
Total seed, etc.		73.08		72.83	66.3	67.8
Total growing costs		110.28		107.41	100.0	100.0
Acreage of potatoes per farm	25 acres		44 acres			
Yield per acre	96 bbls.		121 bbls.			
Cost per barrel		$1.15		$ .89		

Cost of Growing Potatoes. The cost of growing potatoes up to the time of harvesting on the central Maine farms was $110.28 per acre. The largest single cost item was commercial fertilizer which accounted for 39.6 per cent of the total. The cost of labor and equipment was 33.7 per cent of the total cost, including 13.3 per cent for man labor, 11.1 per cent for horse labor, 3.0 per cent for tractor use, 0.7 per cent for truck use, 1.0 per cent for automobile use, and 4.6 per cent for equipment use. The percentage distribution of these cost items was very similar to those on the Presque Isle farms. The cost of growing potatoes on the central Maine farms with comparisons on the Presque Isle farms are set forth in Table 18.

Cost of Harvesting Potatoes. The average cost per acre of harvesting potatoes on the central Maine farms was $16.85 per acre. This amount includes labor, equipment, and other costs. The average cost per barrel of potatoes was 17.5 cents. In comparison, the average cost of harvesting potatoes on the Presque Isle farms was $19.19 per acre. The yield rate of potatoes on the Presque Isle farms was enough higher to make the cost per barrel of potatoes less than on the central Maine farms.

Of the total harvesting cost on the central Maine farms 92.6 per cent was for labor, power, and equipment. This percentage was made up of 67.3 per cent for man labor, 12.6 per cent for horse labor, 2.6 per cent for tractor use, 8.7 per cent for equipment use, and 1.4 per cent for automobile use. On the Presque Isle farms relatively more of the harvesting cost was for man labor, equipment use, and barrels and baskets than on the central Maine farms (Table 19).

Relation of the Combined cost of Growing and Harvesting Potatoes to the Yield Rate. The cost of growing and harvesting potatoes on the central Maine farms varied with the yield rate. The cost per acre increased as the yield per acre increased but the cost per barrel decreased as the yield per acre increased.

The cost per acre in 1930 was $120 when the yield was less than 91 barrels (average 79 barrels) per acre, $128 when the yield was 100 to 109 barrels (average 101 barrels) per acre, and $139 when the yield was 120 or more barrels (average 134 barrels) per acre.

The cost per barrel was $1.55 for the group of farms having an average yield of 79 barrels per acre, $1.26 for the group with an

average per-acre yield of 101 barrels, and $1.05 for the group averaging 134 barrels per acre.

TABLE 19

Costs of Harvesting Potatoes on Potato Farms in Central Maine Compared with Presque Isle, Average of the Two Years, 1929-1930

Item	Average per acre				Proportion of cost	
	Central Maine		Presque Isle		Central Maine	Presque Isle
	Amount	Cost	Amount	Cost		
		dollars		dollars	per cent	per cent
Man labor	23.4 hr.	11.35	21.3 hr.	13.52	67.3	70.4
Horse labor	9.2 hr.	2.13	6.6 hr.	1.63	12.6	8.5
Tractor use	.4 hr.	.44	.3 hr.	.28	2.6	1.5
Equipment use		1.46		1.99	8.7	10.4
Automobile use		.23		.20	1.4	1.0
Total labor and equipment		15.61		17.62	92.6	91.8
Barrels and baskets		1.04		1.39	6.2	7.3
Other costs		.20		.18	1.2	.9
Total barrels, baskets, etc.		1.24		1.57	7.4	8.2
Total harvesting costs		16.85		19.19	100.0	100.0
Acreage of potatoes per farm	25 acres		44 acres			
Yield per acre	96.2 bbls.		120.7 bbls.			
Cost per barrel		17.5 cents		15.9 cents		

An increase of 70 per cent in yield increased the per-acre cost 16 per cent but decreased the per-barrel cost 32 per cent. These comparisons are shown in Table 20.

TABLE 20

Relation of the Combined Cost of Growing and Harvesting Potatoes to the Yield Rate on Potato Farms in Central Maine, 1930

Yield per acre	Number of farms	Average yield per acre	Cost per acre	Cost per barrel
barrels		barrels	dollars	dollars
Less than 90	5	79	120	1.55
90-99	6	96	136	1.42
100-109	16	101	128	1.26
110-119	6	114	129	1.15
120 or more	5	134	139	1.05

Cost of Storing Potatoes. About 62 per cent of the potatoes produced on the central Maine farms were put in storage. Of the average of 60 barrels per acre that were stored, 65 per cent were placed in farm storage and 35 per cent in track storage. In comparison, approximately 72 per cent of the potato production on the Presque Isle farms were stored. This amounted to 87 barrels per acre, of which 85 per cent were in farm storage and 15 per cent in track storage.

The cost of storing potatoes on the central Maine farms averaged $25.20 per acre of potatoes produced. Of this amount 17.4 per cent was for labor, power, and equipment, and 82.6 per cent for storage space, shrinkage in storage, insurance on stored potatoes, interest on the value of stored potatoes, barrels, and other costs. On the Presque Isle farms the storing cost per acre was $38.69, of which 16.4 per cent was accounted for by the cost of labor, power, and equipment, and 83.6 per cent by the other costs mentioned above. The costs of storing potatoes on the central Maine farms with comparisons on the Presque Isle farms are shown in Table 21.

Cost of Selling Potatoes. The cost of selling potatoes on the central Maine farms was relatively low compared with the selling cost on the Presque Isle farms. The cost per acre was low because the number of barrels sold per acre was smaller, and the cost per barrel was lower because a relatively large amount of potatoes was sold directly from the field. Selling from the field does away with the extra handling connected with taking potatoes out of storage. Many potatoes in the central Maine area are purchased at the farm and hauled away by the dealers. This practice also tends to reduce the selling cost of the producer.

The cost per acre of selling potatoes on the central Maine farms was $8.29 per acre. The selling cost per barrel was 9.9 cents. On these farms 83.6 barrels of potatoes were sold per acre. In comparison, on the Presque Isle farms the selling cost was $12.55 per acre and 12.0 cents per barrel. On these farms 104.4 barrels were sold per acre.

Of the total selling cost on the central Maine farms, 92.8 per cent was for labor, power, and equipment. Compared with the Presque Isle farms the central Maine farms had a much larger proportion of the selling cost in truck use, and a smaller proportion in horse labor (Table 22).

TABLE 21

Costs of Storing Potatoes on Potato Farms in Central Maine Compared with Presque Isle, Average of the Two Years, 1929-1930

Item	Average per acre				Proportion of cost	
	Central Maine		Presque Isle		Central Maine	Presque Isle
	Amount	Cost	Amount	Cost		
		dollars		dollars	per cent	per cent
Man labor	4.6 hr.	1.50	6.6 hr.	2.46	5.9	6.3
Horse labor	3.7 hr.	.89	6.0 hr.	1.46	3.5	3.8
Truck use	1.8 hr.	1.64	1.1 hr.	1.52	6.5	3.9
Automobile use		.22		.19	.9	.5
Equipment use		.14		.73	.6	1.9
Total labor, etc.		4.39		6.36	17.4	16.4
Farmers' storage		1.07		3.06	4.3	7.9
Hired storage		3.81		2.13	15.1	5.5
Shrinkage		12.21		22.04	48.5	57.0
Insurance on stored potatoes		.81		1.36	3.2	3.5
Interest on stored potatoes		1.79		2.59	7.1	6.7
Barrels		.92		.97	3.6	2.5
Other costs		.20		.18	.8	.5
Total storage, etc.		20.81		32.33	82.6	83.6
Total storing costs		25.20		38.69	100.0	100.0
Potatoes removed from storage per acre	60 barrels		87 barrels			
Storing cost per barrel removed		42 cents		44 cents		
Proportion of stored potatoes in farm storage	65 per cent		85 per cent			
Proportion of stored potatoes in track storage	35 per cent		15 per cent			

Relation of the Cost of Selling Potatoes to the Amount Sold. The relationship between the cost of selling potatoes and the amount sold on the central Maine farms is indicated in Table 23. On the farms for which less than 1,000 barrels of potatoes (average 850 barrels) were sold per farm, the average selling cost was 18.0 cents per barrel. On the farms selling 2,000 to 2,999 (average 2,350 barrels), the cost of selling per barrel was 9.8 cents, and on the farms selling 4,000 or more barrels (average 4,700 barrels), the average cost was 9.2 cents per barrel.

FARM ORGANIZATION OF POTATO FARMS IN AROOSTOOK COUNTY, MAINE, IN 1935 COMPARED WITH 1928-1930. In the summer of 1936 information on farm organization was obtained

TABLE 22

Costs of Selling Potatoes on Potato Farms in Central Maine Compared with Presque Isle, Average of the Two Years, 1929-1930

Item	Average per acre				Proportion of cost	
	Central Maine		Presque Isle		Central Maine	Presque Isle
	Amount	Cost	Amount	Cost		
		dollars		dollars	per cent	per cent
Man labor	9.6 hr.	3.21	13.2 hr.	5.06	38.7	40.3
Horse labor	4.5 hr.	1.02	16.5 hr.	4.03	12.3	32.1
Truck use	3.0 hr.	2.68	1.6 hr.	2.08	32.3	16.6
Automobile use		.22		.19	2.7	1.5
Equipment use		.56		.70	6.8	5.6
Total labor, etc.		7.69		12.06	92.8	96.1
Sacks		.40		.31	4.8	2.5
Other costs		.20		.18	2.4	1.4
Total sacks, etc.		.60		.49	7.2	3.9
Total selling cost		8.29		12.55	100.0	100.0
Potatoes sold per acre	83.6 bbls.		104.4 bbls.			
Cost per barrel of potatoes sold		9.9 cents		12.0 cents		

TABLE 23

Relation of the Cost of Selling Potatoes to the Amount Sold on Potato Farms in Central Maine, Average of the Two Years, 1929-1930

Amount of potatoes sold per farm	Number of farms	Average amount of potatoes sold	Selling cost per barrel
barrels		barrels	cents
Less than 1000	5	850	18.0
1000-1999	15	1450	10.5
2000-2999	12	2350	9.8
3000-3999	3	3750	8.2
4000 or more	3	4700	9.2

for the crop year 1935 from 310 potato producers in Aroostook County. Tentative comparisons are made of the farm acreage, livestock, and capital of the farms of this region between the 1935 crop year and the average of the three crop years 1928-30.

Farm Acreage. The average total farm acreage in 1935 was 186 acres per farm compared with 170 acres in 1928-30. This is a 9 per cent increase and is mostly accounted for by the difference

in the acreage of woods not pastured. The crop acreage, the pasture acreage, and the acreage in farmsteads and roads were practically the same in 1935 as in 1928-30. More than 50 per cent of the farm acreage was in crop land. Pasture land accounted for 12 per cent and farmsteads and roads 4 per cent (Table 24).

TABLE 24

Distribution of the Farm Acreage on Potato Farms in Aroostook County, Maine, 1935 and 1928-1930

Item	Acres per farm		Per cent of acres	
	1935	1928-30	1935	1928-30
Crop acres	101	102	54	59
Woods not pastured	56	40	30	24
Woods pastured and open pasture	22	22	12	13
Farmsteads, roads, etc.	7	6	4	4
Total	186	170	100	100

Crop Acreage. The total crop acreage and the distribution of the crop acreage among the different crops varied but little between the two periods. In 1935 the crop acreage totaled 101 acres composed of 38 acres of potatoes, 24 acres of grain, 35 acres of hay, 3 acres of green manure crops, and 1 acre of other crops. In 1928-30 there were 102 crop acres including 41 acres of potatoes, 23 acres of grain, 34 acres of hay, 3 acres of green manure crops, and 1 acre of other crops (Table 25).

TABLE 25

Distribution of the Crop Acreage on Potato Farms in Aroostook County, Maine, 1935 and 1928-1930

Item	Acres per farm		Per cent of acres	
	1935	1928-30	1935	1928-30
Potatoes	38	41	38	39
Grain	24	23	24	23
Mixed hay	20	17	20	17
New-seeded hay	15	17	14	17
Green manure	3	3	3	3
Other	1	1	1	1
Total	101	102	100	100

Livestock. In 1935 the number of each kind of livestock kept on the Aroostook County potato farms was larger than in 1928-30 with the exception of beef animals and horses. Since 1928-30 the number of dairy cows increased 44 per cent; dairy heifers and calves, 100 per cent; dairy bulls, 100 per cent; sheep, 15 per cent; hogs, 157 per cent; and hens, 113 per cent. The number of beef animals was the same and the number of horses decreased 20 per cent. In 1935 the average number of dairy cows per farm was 3.9, dairy heifers and calves, 3.1; dairy bulls, 0.4; sheep, 2.3; hogs, 7.2; and hens, 62.1. Beef animals averaged 0.3 and horses averaged 3.7 per farm (Table 26).

TABLE 26

Distribution of Livestock on Potato Farms in Aroostook County, Maine, 1935 and 1928-1930

Item	Number of animals per farm	
	1935	1928-30
Dairy cows	3.9	2.7
Dairy heifers and calves	3.1	1.5
Dairy bulls	.4	.2
Total dairy animals	7.4	4.4
Beef animals	.3	.3
Horses	3.7	4.6
Sheep	2.3	2.0
Hogs	7.2	2.8
Hens and chickens	62.1	29.1

Farm Capital. It is evident that during the recent depression there has been a considerable downward revision of values on Aroostook County farms. The decrease in values is apparent even though there was no decrease in farm acreage, and though there was a considerable increase in the number of livestock. The farm capital of $17,658 per farm in 1935 is 39 per cent less than the $28,815 per farm in 1928-30. The value of each of the items, real estate, machinery, livestock, and feeds and supplies was less in 1935 than in 1928-30. The value of real estate was 40 per cent less, of machinery 19 per cent, and of livestock 18 per cent. The distribution of farm capital is shown in Table 27.

Capital in Real Estate. The total real estate capital averaged $14,552 per farm in 1935 compared with $24,168 per farm in 1928-

TABLE 27

Distribution of Capital on Potato Farms in Aroostook County, Maine, 1935 and 1928-1930

Item	Capital per farm		Per cent of capital	
	1935	1928-30	1935	1928-30
Real estate	$14552	$24168	83	83
Machinery	1830	2262	10	8
Livestock	1130	1374	6	5
Feeds and supplies	146	1011	1	4
Total	$17658	$28815	100	100

30. The value of all buildings was 44 per cent less in 1935 than in 1928-30 and of all land 37 per cent less. The operators' dwellings decreased 49 per cent in value since 1928-30, barns 43 per cent, potato storage houses 30 per cent, and other buildings 44 per cent. The value of crop land decreased 35 per cent, woodland 44 per cent, and pasture land 56 per cent. The distribution of real estate capital is shown in Table 28.

TABLE 28

Distribution of Capital in Real Estate on Potato Farms in Aroostook County, Maine, 1935 and 1928-1930

Item	Real estate capital per farm		Per cent	
	1935	1928-30	1935	1928-30
Operators' dwellings	$ 2127	$ 4197	15	17
Barns	1745	3081	12	13
Potato storage houses	1003	1432	7	6
Other buildings	586	1041	4	4
Total buildings	$ 5461	$ 9751	38	40
Crop land	$ 7922	$12116	54	51
Woodland	853	1531	6	6
Pasture land	301	689	2	3
Land partly cleared	15	81	—[1]	—[1]
Total land	$ 9091	$14417	62	60
Total real estate	$14552	$24168	100	100

[1] Less than 1 per cent (.001).

Capital in Machinery. The value of farm machinery averaged $1,831 per farm in 1935 and $2,262 per farm in 1928-30. One-fourth of this value in each case was for trucks and tractors and

three-fourths for the remainder of the farm machinery. The per farm value of trucks was 37 per cent less in 1935 than in 1928-30. The value of tractors, however, was only 6 per cent less. The value of the other machinery was 18 per cent less. The number of tractors and of trucks per farm was about the same in 1935 as in 1928-30. Tractors averaged about 0.7 per farm in each period. Trucks averaged 0.7 per farm in 1935 and 0.6 per farm in 1928-30 (Table 29).

TABLE 29

Distribution of Capital in Machinery on Potato Farms in Aroostook County, Maine, 1935 and 1928-1930

Item	Machinery capital per farm		Per cent	
	1935	1928-30	1935	1928-30
Trucks	$ 177	$ 280	10	12
Tractors	275	293	15	13
Other machinery	1378	1689	75	75
Total	$1830	$2262	100	100
Number of trucks per farm	0.7	0.6		
Number of tractors per farm	0.7	0.7		

FERTILIZER EXPERIMENTS WITH POTATOES IN PERMANENT PLOTS. Joseph A. Chucka and Arthur Hawkins. Although the potatoes were planted later than usual (June 6) on the permanent plots at Aroostook Farm the 1936 yields were the highest ever obtained on these plots. A favorable growing season without a killing frost until late September together with good blight control was responsible for the high yields obtained in spite of the late planting.

The response to heavy fertilization was particularly great in 1936 as indicated by the data presented in the following table.

Data obtained in previous years indicate that a smaller response to heavy fertilization may be expected during seasons with less favorable rainfall distribution and during those seasons when late blight or early frost kills the potato vines early in September.

The remaining data secured from the permanent fertility plots in 1936 were in general agreement with data secured in the past. The only exception was that a somewhat greater response to increasing amounts of nitrogen was obtained in potato fertilizers.

TABLE 30

Effect of Applied Fertilizer on Potato Yields

Fertilizer treatment	Per acre yield	
Pounds per acre	Bushels	Barrels
No fertilizer	102	37
1500 lbs. 4-8-7	411	150
2000 lbs. 4-8-7	458	167
2500 lbs. 4-8-7	507	184
3000 lbs. 4-8-7	535	195

Potato Fertilizer Tests Conducted on Privately Owned Farms Throughout Aroostook County. Joseph A. Chucka and Arthur Hawkins in cooperation with B. E. Brown of the Bureau of Plant Industry, United States Department of Agriculture. *Potash-Magnesium Test.* The comparison of potato fertilizers varying in percentage of potash and made up both with and without added magnesium was continued on two farms during the past season. In the series without added magnesium the highest average yield was obtained with the 4-8-5 fertilizer, whereas in the series with added magnesium the highest yield was obtained with the 4-8-10 treatment. The series with added magnesium produced an average of about 5 more barrels of potatoes than the series without added magnesium. This indicates that added magnesium in potato fertilizers continues to be profitable under Aroostook conditions.

Acid versus Neutral Fertilizer Test. As in previous years no significant difference in yield of potatoes was obtained with neutral as compared with acid potato fertilizers on the two farms where this test was conducted.

Rate of Fertilizer Test. Double strength fertilizer (8-16-14) was applied at different rates varying from 500 to 1,500 pounds per acre on both Irish Cobblers and Green Mountains on each of two farms. The data obtained showed that both varieties responded well to heavy fertilization. The response obtained on these two farms was somewhat smaller than that obtained on the permanent plots at Aroostook Farm.

Seed Spacing-Rate Test. In view of the increasing demand for smaller seed potatoes it seemed advisable to obtain some information on the effect of close planting on yield and on size of tubers. Accordingly, Irish Cobblers were spaced 7.5, 9, and 12 inches in

the row and four rates of fertilizer (750, 1,000, 1,250, and 1,500 pounds per acre of 8-16-14) were used with each seed spacing. Yields increased with closeness of spacing and with increased fertilizer applications. The smallest spacing (7.5 inches) did not materially reduce the size of tubers in 1936 and consequently a six inch spacing will be included in this test next year.

Uncommon Element Test. In the uncommon element test, fertilizers with and without small quantities of iron, manganese, copper, zinc, nickel, and boron were compared on each of two farms. With the exception of boron, the elements were added at the rates of 25 and 50 pounds per acre of the sulfates of the elements. Boron was added at 2.5 and 5.0 pounds per acre of borax. Under the conditions of the test none of the elements produced any beneficial effects. Both nickel and boron, at the heavier rates, produced significant reductions in yield.

Source of Phosphorus Test. The source of phosphorus test included a comparison of twelve different materials as sources of phosphorus in potato fertilizers. Several of the new materials produced by the Tennessee Valley Authority are being compared with the older phosphorus carriers. Since a very low response from phosphorus was obtained on the farm where this test was conducted during the past season, it is inadvisable to make any statement at this time as to the comparative value of the materials.

COOKING QUALITIES OF POTATOES. Marion D. Sweetman and Pearl S. Greene. In variety tests made in November on stock from the 1936 crop at Aroostook Farm, Green Mountains were the most mealy, Warba, Katahdin, and Irish Cobbler in a second group, followed by Chippewa and Bliss Triumph in the order named. These ratings agree with tests of four previous years on the Green Mountain, Irish Cobbler, and Bliss Triumph varieties, and with those of two previous years on the Green Mountain, Irish Cobbler, Chippewa, and Bliss Triumph varieties except that the Chippewa was closer to the Irish Cobbler in the previous years. The 1936 sample of the Katahdin variety was superior to the stock tested in 1935.

When these tests were repeated in January on similar stock held under similar but uncontrolled conditions, all varieties were less mealy but the Green Mountain had changed the least and was followed by the Katahdin and Irish Cobbler, but the Warba dropped

to a third class with the Bliss Triumph, and the Chippewa was the least mealy of the group.

The samples of the Green Mountain variety from the fertilizer plots were not tested until March first when some sprouting had developed in some lots. Consequently the results are not comparable to those of previous years.

GREEN MOUNTAIN SEED PLOTS. Donald Folsom. Tuberline seed grown on Highmoor Farm under an aster-cloth cage in 1933 and in the open in 1934, and on commercial farms in seed plots in 1935, was planted again in 1936 and examined for virus-disease content. This content was found to have increased from about one-tenth of one per cent to an average, for the different stocks, of about nine-tenths of one per cent. Spindle tuber remained absent, yellowtop disappeared from all but one stock, and most of the increase was in mosaic and leaf roll.

A study of the records was made to disclose any relationships between different conditions and the disease content in 1936. There was no significant effect from disease content in 1935. Poorer isolation in 1935 resulted in significantly more mosaic in 1936, but had no such effect on leaf roll. As the distance of the seed plot in 1935 from the southwestern corner of the State increased, the greater was the percentage of mosaic and the less the percentage of leaf roll ($r = +0.442$ for mosaic and -0.395 for leaf roll for 29 plots). In this connection, location in 1935 had the following significant effect on disease content in 1936:

	Mosaic 1936	Leaf roll 1936
In Aroostook County 1935	0.61%	0.02%
Outside Aroostook County 1935	0.01%	0.94%

The size of seed plot, earliness of planting and development, and tuber-unit planting in 1935, had no significant effects on disease content in 1936, and such trends as were shown were explainable on the basis of location, Aroostook County plots happening to be generally smaller, medium early, and tuber-unit.

The various conditions mentioned were all considered in 1935 and a preliminary ranking then estimated for the different stocks. The correlation between the estimated and actual rankings proved to be highly significant ($r = +0.540$ for mosaic and $+0.615$ for leaf roll).

The aster-cloth cage was not erected in 1935 until some of the plants had emerged from the soil and by that time some aphids were present. These were kept to low numbers by nicotine spraying, but the original migrants infected two tubers with leaf roll, on the three-tenths acre under cloth, as shown by the progeny in 1936.

The stock grown in the open on Highmoor Farm in 1935 was replanted in 1936 in over 20 plots whose area totaled about 27 acres. In this stock in 1936 there was still no mosaic, but enough leaf roll had entered in 1935 to make the percentage about one-eighth of one per cent. Yet in 1935 the Highmoor Farm seed plots had been isolated by what is generally regarded as an ample distance.

THE VALUE OF SELECTING SEED STOCK THAT IS FREE FROM RHIZOCTONIA. Reiner Bonde and Lawrence A. Schaal. A study is being conducted to determine the advantage of selecting seed tubers that are free from rhizoctonia. It was thought that by this method it might be possible to reduce greatly the amount of this disease in certain seed stocks. The Irish Cobbler variety was chosen for this study because it has appeared to be more susceptible to heavy infestation than the other varieties grown in Maine.

The tubers were selected the previous fall at the time the seed plots were being dug. The tubers were washed in water and critically examined for black scurf. The disease-free tubers, selected in this manner, were planted on 25 different farms in comparison with similar seed that had not been selected and was infested by the fungus. The different plots were harvested the following fall and the amount of infestation for the different lots of seed noted.

According to the data secured in this test the amount of rhizoctonia was reduced in all cases and eliminated in some plots. Rhizoctonia appeared to be more prevalent in the plots located in southern Maine than in Aroostook County.

The data, given in Table 31, show that the selection of disease-free tubers tends to produce a smoother and nicer appearing progeny. The yield was also increased by the selection process as is shown in the following table and from the data of previous seasons.

It is seen that selected tubers yielded more than those that had not been selected for freedom from rhizoctonia.

TABLE 31

Comparison of Yields from Rhizoctonia Infected and Disease-Free Tubers Receiving Different Treatments

Treatment	Yield barrels per acre		
	Seed tubers selected free from rhizoctonia	Seed infected with rhizoctonia	Barrels in favor of selected seed
Corrosive sublimate standard treatment	175±2.43	171±3.06	4
Sanoseed dip method	176±2.93	165±3.51	11
Untreated control	179±3.71	149±3.18	30

SPRAYING AND DUSTING POTATOES. Reiner Bonde. The season of 1936 in Aroostook County was characterized by being extremely late and by the fact that the rainfall was excessive throughout most of the summer. The year was also characterized by one of the severest late blight or rust epidemics in Aroostook history. The rust disease was present in certain low lying fields along the Aroostook River the second week of July and caused a great amount of damage. The disease became generally distributed in most parts of the County and it was only through a very intensive spray program that enormous losses were avoided. The loss caused by rust was especially serious in some areas in the vicinity of Limestone.

The growing season was late and lasted until the latter part of September. This fact accounted for the large yields secured by some growers in spite of the lateness of the time of planting. Many growers suffered losses because of tuber rot caused by the rust fungus. Prolonged periods of rainy and misty weather prevailed in September and the rust infection that was latent in the diseased potato tops took on new life and produced spores freely. These spores were washed into the soil and inoculated the tubers, resulting in a large amount of rot. In some cases, because the season was late, the growers dug their crop while some green and diseased foliage still persisted. The infected foliage inoculated the tubers in the digging process. Tubers inoculated at this time developed bin decay and dry rot. Some confusion resulted as to the amount of bin rot due to rust, because some growers experienced losses from field frost, which resulted in a considerable amount of soft decay in the storage bins.

Comparison of Different Spray Schedules. The relative value of different times of applying spray to potatoes was studied again in 1936 under the condition of a severe rust epidemic. Four different spray schedules were followed. One series of plots was sprayed at intervals varying from 8 to 10 days during the entire season beginning early while the plants were small and continuing until the plants were killed by frost. The early spray applications were omitted in another series of plots and the late applications (after August 19) were omitted in a third. The fourth spray schedule consisted of delaying the first schedule until July 22 and also omitting the late applications.

These tests brought out valuable information. Omitting the early spray applications did not appear to favor rust development and reduce the yield, provided modern equipment was used for making the later applications. In these experiments a 3-nozzle-per-row boom, applying 140 gallons per acre, was employed. Observations, however, indicate that with a less modern spray rig, applying only 70 to 80 gallons per acre and equipped with a 2-nozzle-per-row boom, the early spray applications may be of considerable value. Therefore it can be stated that spraying should be started earlier in the season wherever it is necessary to use the less efficient machinery.

Omitting the spray applications after August 19 was detrimental and resulted in some reduction of yield. There was also an increase in the amount of tuber rot in those plots where the late applications were omitted. There occurred during September in 1936 a prolonged period of rain that was especially favorable for the development of rust. It is felt that much of the loss in 1936 caused by bin rot resulted from tuber infection occurring in September. The rot was most abundant in stocks from those fields where the rust disease had been incompletely controlled. It is therefore felt that better and more efficient spraying equipment would have prevented much bin rot. Also, even with the less efficient spraying machinery late spray applications were highly beneficial.

Insects, especially flea beetles, were not abundant in the spray plots of 1936 so that any differences secured by the different treatments were not the result of insect injury.

Yield at Different Dates of Potatoes Receiving Different Fungicidal Treatments. A study is being made of the relative growth rate of potatoes receiving different fungicidal treatments for the

control of rust and insects. In these studies parts of the plots receiving the different treatments were harvested at different dates during the growing season and the yields compared. The treatments were tested on fairly uniform soil and were replicated 8 times, a fact that should make the data fairly reliable. The data are summarized in Table 32.

TABLE 32

Yield Rates at Different Dates for Potatoes Having Received Different Fungicidal Treatments

Date harvested	Barrels per acre for different treatments[1]			
	Bordeaux mixture	Basi-Cop	Copper lime dust	Unsprayed controls
August 21	80±1.05	84±0.64	77±1.50	86±1.32
September 2	145±1.74	151±1.51	149±0.91	126±1.52
September 11	162±2.14	171±1.94	166±1.66	136±2.42
September 21	184±2.21	192±1.26	184±1.69	133±3.25

[1] The yields reported here are the means of eight 50-foot four-row replicated plots for each treatment. The plots were harvested by hand and the weighings made on a spring balance in the field.

It is seen that on August 21 the unsprayed control plots yielded somewhat more than those that had received the fungicidal treatments. By that time, however, the rust disease had made its appearance in the unsprayed plots which resulted thereafter in a lower yield rate in comparison with the sprayed plots. It is interesting to compare these results with those of 1935 when, in the absence of disease, the checks yielded more than the Bordeaux mixture plots until September 9. After that date the unsprayed plots matured rapidly in contrast to those that had been sprayed which continued to grow and develop tubers.

It is also interesting that the crop in the 1935 spray plots increased approximately 20 barrels per acre (55 bushels) from September 11 to September 21. In 1936, the increase in yield from September 11 to September 21 in corresponding spray plots was 22 barrels per acre. It is concluded that the high yields secured by some growers in such seasons can be attributed to a considerable degree to the prolonged growing season. Such high yields cannot be obtained unless the vines are kept alive by spraying.

The Effect of Added Compounds on the Adhesiveness of Bordeaux Mixture and Copper Lime Dust. The season of 1936, being

characterized by an excessive amount of rainfall, afforded ideal conditions for testing the relative adhesiveness of copper fungicides of different types. The data indicate that Bordeaux made with a dolomitic lime adheres to the potato foliage as well as that made with a high calcium lime. Some of the commercially manufactured fungicides do not adhere as well as the homemade Bordeaux. They controlled the disease, however, in spite of this fact.

Several compounds including bentonite, SS-3, Aresket, and Tar Flakes were added to homemade Bordeaux and to copper lime dust to learn whether they increased the sticking properties of the fungicides. Leaf samples were collected from the respective plots for the purpose of calculating the amount of copper retained by the foliage. The analyses are not yet completed.

Production of a Late Blight or Rust Epidemic on Aroostook Farm in 1936. Late blight or rust generally has appeared later on Aroostook Farm than on farms in the nearby vicinity. It is also true that the extent of the infection has been less than in the other parts of Aroostook County. Rust was absent on Aroostook Farm, in 1936, until July 18 when the disease was introduced for experimental purposes. Fifty infected leaves from a field near the river in the vicinity of Fort Fairfield were brought to the laboratory and the spores washed off into a pail of water. This water, containing the late blight spores, was sprinkled onto an acre of unsprayed potato seedlings and Green Mountains, which were being compared for resistance to the disease.

The weather was moist, but too cool for rapid development of the disease, and the symptoms of infection did not appear until July 24. On that date the spots of infection were very small and resembled the early stages of early blight. These spots produced spores within 24 hours. A misty rain and fog accompanied by a wind from the southeast prevailed for several days after the spores had developed. These conditions resulted in the infection being distributed to an actively growing adjacent Green Mountain field that possessed a large amount of unsprayed foliage. The rust disease was contracted by practically every plant for a distance of 500 feet in the direction in which the prevailing wind blew. The disease was absent in the fields located in the other directions and was not found on those fields that had been sprayed just prior to July 24.

These results throw light on the reason why some growers failed to control the disease. Rains and suitable weather for the development of late blight prevailed throughout a large portion of July and the growth of the potato plants was also very rapid. The result was that some growers were unable, with their present equipment, to keep the foliage covered and protected during the critical period.

This experiment demonstrates how essential it is to have the foliage covered at the time when the disease is being carried by the wind. A spray application made early in the season when the plants were small did not prevent later infection of the leaves still expanding at the time of spraying. However, an application made just prior to the time when the fungus was fruiting and being disseminated greatly reduced the amount of loss that resulted.

An attempt was made to learn whether the disease could be prevented from spreading from one part of a plant to another after the infection previously described had occurred. It was shown that the initial infection was not controlled but that secondary infection or further spread from the primary lesions could be prevented to a large extent.

The yield data for this comparison are given in Table 33. It is shown that the epidemic reduced the yield at the rate of 76 barrels per acre which is a loss similar to that experienced by some growers.

TABLE 33

The Effect of Late Blight Infestation on the Yield Rate

Treatment	Yield rate in barrels per acre	Loss in barrels per acre due to rust infestation
Sprayed plots not affected with late blight	147±1.73	—
Sprayed plots affected with late blight	71±1.94	76
Unsprayed controls. Killed early in season by late blight	42±3.64	105

Comparison of Bordeaux Mixture and Basic Copper Sulphate. Many potato growers in Maine are interested in securing a new spray material that will control diseases and insects, and also will

be easier to prepare and apply than the commonly used Bordeaux mixture. Therefore there has been some interest regarding the merit of Basic Copper Sulphate as a fungicide for potatoes. This commercially prepared fungicide was compared in experimental test plots in both Aroostook and Piscataquis Counties during the season of 1936. The Bordeaux mixture used in these tests was prepared according to the 10-10-100 formula and the Basic Copper Sulphate was used at the rate of 5 pounds per 100 gallons of water.

The yields secured in these test plots are recorded in Table 34. It is seen that in Aroostook County the plots sprayed with Basic Copper Sulphate yielded approximately the same as those sprayed with Bordeaux mixture. However, in Piscataquis County this spray material did not produce as good results. The data at hand suggest that Basic Copper Sulphate may not be as good a spray material in southern and central Maine as in Aroostook County where the conditions are quite different.

TABLE 34

Comparisons of Yields from Plots Sprayed with Bordeaux Mixture and with Basic Copper Sulphate

Location of plots	Yield rate per acre				Barrels difference in favor Bordeaux	Odds in favor Bordeaux
	Bordeaux mixture		Basic copper sulphate			
	Barrels	Bushels	Barrels	Bushels		
At Presque Isle on Aroostook Farm	186±1.60	512±4.41	185± .81	509±2.25	1	1 to 1
At Presque Isle on Aroostook Farm	198±1.51	545±4.14	195±1.44	536±3.84	8	1 to 1
At South Sangerville in Piscataquis County[1]	135±3.20	371±8.80	121±2.40	333±7.00	14	53.95 to 1

[1] Conducted under the supervision of Oscar Wyman, Assistant Crop Specialist, Maine Extension Service, on the farm of C. E. Grant.

The plots in Aroostook County were subjected to a very severe epidemic of late blight or rust. In these rather rigid tests Basic Copper Sulphate afforded good control of the disease. It is the opinion of the writer that this material is not quite as efficient in the control of the rust disease as Bordeaux and therefore growers should use more caution during the critical spray periods when Basic Copper Sulphate is being used. Basic Copper Sulphate is, however, very convenient to use and does not discolor the foliage.

The latter factor may be of special importance for seed growers where roguing of the fields is advisable.

Dusting vs. Spraying of Potatoes of Different Varieties. Copper lime dust and Bordeaux mixture have been compared on experimental plots in Aroostook County for a number of years. Most of the studies previous to 1936 were made with the Green Mountain variety. Some data and observations have indicated that the dust fungicide is better suited than spray for the earlier varieties, contrary to results with the later varieties.

In 1936 the comparison of copper lime dust and Bordeaux mixture was extended to include not only Green Mountains but also the Irish Cobbler and Chippewa varieties. The Cobbler variey is earliest and the Chippewa variety is approximately 10 days earlier than the Green Mountain in Aroostook County.

The plots all received 7 applications of fungicide during the season. The Bordeaux and copper lime dust applications were made on the same days on the respective plots, a fact that should help to make the test fairly reliable.

The yields secured from these comparisons are summarized in Table 35. It may be seen there that the sprayed plots yielded more than the dusted plots in the tests for all of the three varieties. The

TABLE 35

Comparison of Bordeaux Mixture and Copper Lime Dust on Different Varieties of Potatoes[1]

Variety	Yield rate in barrels per acre			Odds
	Bordeaux mixture	Copper lime dust	Barrels difference in favor Bordeaux	
Green Mountain	186±1.60	182±2.87	4	1 to 1
Irish Cobbler	171±2.04	161±2.52	10	37.4 to 1
Chippewa	198±2.86	170±5.05	28	19230 to 1

[1] The plots were all subjected to very severe natural late blight inoculations. The disease was controlled well in all plots. Insects apparently were not a factor in these tests.

gain was significant for the Irish Cobbler and Chippewas but not in the test with Green Mountains. Tests of previous years have indicated that as a general rule spraying with Bordeaux will give somewhat higher yields than will a dust fungicide when used on the Green Mountain variety.

The Bordeaux-*vs.*-dust experiment was subjected to conditions that were very favorable for the development of late blight. Both the spray and the dust treatments gave good control of the disease in these tests.

Other Comparisons of Spray Fungicides. There appears to be need for a potato fungicide that will control disease and insects and also be more convenient to prepare and apply than Bordeaux mixture. The writer is of the opinion that an efficient fungicide that does not discolor the foliage would be beneficial in that it would facilitate roguing of diseased plants without the commonly encountered danger of masking. It is also felt that Bordeaux may retard plant growth and reduce yields in northeastern Maine.

In 1936, different fungicides were compared on Aroostook Farm under very severe late blight or rust conditions. The fungicides were applied according to the rates recommended by the manufacturers of the different products and not according to the copper content of the products.

The data pertaining to this test have been summarized in Table 36. According to the data Bordeaux #34 and Chipman Copper Hydro "40" were as good as Bordeaux in fungicidal properties. Bordeaux #34 yielded slightly more and Chipman Copper Hydro "40" yielded somewhat less than the Bordeaux check plots. It is doubtful whether these differences were of much significance in this test.

Coposil, in tests conducted in 1935 when the late blight disease was absent, appeared superior to Bordeaux. However, in 1936, with blight prevalent, this material failed to control the disease at the concentration (3 pounds in 100 gallons) that was recommended. It is quite likely that if the amount of this fungicide used had been increased, or if additional applications had been made, especially in the latter part of the season, better control of the disease would have been secured.

"Super Copper," when used at the rate of 1 quart per 100 gallons of water, did not afford good blight control, and Sulfocide failed to show much fungicidal value for the disease involved in this experiment.

Copper phosphate appeared to be a fairly good fungicide. However, in the test reported here, the plants matured earlier than for the other treatments, a fact that might explain the somewhat smaller yield secured with this product.

TABLE 36

Comparisons of Yields of Potatoes from Plots, Sprayed with Different Fungicides, in the Presence of a Severe Late Blight Epidemic in 1936

Fungicide[1]	Yield in barrels per acre	Barrels gain or loss compared with Bordeaux	Remarks
Bordeaux control (10-10-100)	183±1.47	—	Excellent appearance
Coposil 3 pounds per 100 gallons water	160±3.65	28 loss	Became infested with late blight after Septmber 7, resulting in considerable tuber rot
Bordeaux #34, 6 pounds per 100 gallons water	194±2.63	6 gain	Very good appearance, possibly slightly inferior to that with Bordeaux
Chipman Copper Hydro "40," 8 pounds per 100 gallons water	183±1.79	5 loss	Excellent appearance
"Super Copper," 1 quart to 100 gallons water, and Aresket[2] as a sticker	146±2.91	42 loss	Some late blight appeared early
Copper phosphate Grade B, 4 pounds per 100 gallons water, and Aresket as a sticker	180±2.17	8 loss	Controlled late blight well but plants matured early
Copper cyanamid, 10 pounds per 100 gallons water, and Aresket as a sticker	177±3.28	11 loss	Some late blight appeared late in season. Plants matured early
Sulfocide, 5½ pints to 100 gallons water	153±2.89	35 loss	Very little fungicidal control
Unsprayed control	108±1.67	80 loss	Killed by late blight early in season

[1]Coposil is said to contain 22 per cent metallic copper and from 6 to 7 per cent metallic zinc. Supplied by California Spray-Chemical Company, Elizabeth, N. J.

Bordeaux #34 is said to contain 34 per cent metallic copper. Supplied by the General Chemical Company, 40 Rector Street, New York, N. Y.

Chipman Copper Hydro "40" is said to contain 40 per cent copper hydroxide or 26 per cent metallic copper. Supplied by Chipman Chemical Company, Bound Brook, N. J.

"Super Copper" is said to contain 15 per cent metallic copper. Supplied by Hammond Paint and Chemical Company, Beacon, N. Y.

Copper Phosphate is said to contain 44.3 per cent metallic copper. Supplied by Monsanto Chemical Company, St. Louis, Mo.

Copper cyanamid is said to contain 21 per cent metallic copper. Supplied by American Cyanamid Company, New York, N. Y.

Sulfocide supplied by B. G. Pratt Company, 50 Church Street, New York, N. Y.

[2] Dry Aresket, supplied by the Monsanto Chemical Company, was used as a sticker at the rate of 2 ounces per 100 gallons of water.

Copper cyanamid showed a considerable amount of fungicidal value. The plants sprayed with it, however, also matured earlier than did the Bordeaux control plots.

Yield Comparison with Dolomitic Hydrated Lime vs. High Calcium Hydrated Lime in the Preparation of Bordeaux Mixture. Previously conducted spraying experiments have indicated that Bordeaux mixture prepared with a dolomitic hydrated lime is

superior to a Bordeaux made with high calcium lime. The tests prior to 1936 were conducted in the absence of late blight. In 1936, similar comparisons were made in the presence of a very severe late blight epidemic.

The experiment of 1936 was conducted on two different fields. The soil of one field had been in clover sod the previous season and was high in organic matter. The other field was low in organic matter and had been cropped continually with potatoes for several years. The plots in both fields received 7 spray applications during the season.

The yields for these comparisons have been summarized in Table 37. The data substantiate the conclusion from previous years' work, that Bordeaux prepared with dolomitic hydrated lime is somewhat superior, or at least equivalent, to that made with high calcium hydrated lime when used in northeastern Maine. The experiment also showed that dolomitic lime Bordeaux is a good fungicide and able to control the rust disease efficiently under severe conditions for infection.

TABLE 37

Comparison of Bordeaux Made with Dolomitic and High Calcium Hydrated Lime

Kind of spray material	Yield rate in barrels per acre	
	On good land	On poor land
Bordeaux made with dolomitic hydrated lime containing 33% MgO	169±2.16	132± .96
Bordeaux made with calcium hydrated lime containing 1% MgO	166±2.18	127±1.71
Unsprayed controls	110±2.95	103±2.38

Yield Comparison with Different Amounts of Lime in the Formula for Making Bordeaux Mixture. Data supplied by experiments conducted on Aroostook Farm have indicated that Bordeaux mixture on the potato leaves is a retarding factor in the growth and development of the potato plant. There is also evidence that fungicides that do not coat the leaves with a heavy residue are superior to Bordeaux under the conditions of northeastern Maine.

In 1936 a series of plots was devoted to testing the effect of different amounts of lime in the Bordeaux mixture formula. Both dolomitic hydrated lime containing 33 per cent magnesium oxide and

a high calcium hydrated lime containing only 1 per cent magnesium oxide were used in these tests. The data derived from the comparisons have been summarized in Table 38.

TABLE 38

Yield Comparisons of Potatoes Receiving Different Amounts of Lime in the Formula for Making Bordeaux Mixture

Type of lime	Pounds of lime used per 100 gallons of Bordeaux	Yield in barrels per acre
Dolomitic hydrated lime containing 33% MgO	10.0	169±2.16
Do.	5.0	167±1.30
Do.	2.5	160±1.76
High calcium hydrated lime containing 1% MgO	10.0	166±2.18
Do.	5.0	164±1.39
Unsprayed controls	—	111±2.95

According to the data recorded in Table 38 the yield was not increased by a reduction in the amount of lime used in the Bordeaux. In fact, 10 pounds of lime per 100 gallons of spray material (10-10-100) yielded somewhat more than 5 pounds for both kinds of Bordeaux mixtures. The differences are, however, not of great significance.

The reduction of the amount of lime to 2.5 pounds for 100 gallons of Bordeaux did not result in foliage injury. This formula did not, however, give satisfactory control of disease when the late blight epidemic became severe. Bordeaux with either kind of lime controlled the disease when the lime was used at the rate of 5 and 10 pounds for each 100 gallons of water and 10 pounds of copper sulphate.

Spray Service. The spray service conducted in cooperation with the Aroostook County Farm Bureau was continued in 1936 as in previous years. The voluntary enrollment for this service has increased from 81 in 1931 to 3,046 in 1936.

Through this service the growers and farmers receive timely information regarding the prevalence of late blight. This information is disseminated by various methods. Each of the members enrolled for the spray service receives through the mail a post card informing him when it is intended to make a spray application on Aroostook Farm. This information is often supplemented by

circular letters. It is also the practice to disseminate current news items regarding the status of the disease in the County by means of radio talks and articles printed in the local newspapers.

New Rust Resistant Varieties of Potatoes. Progress is being made through the breeding program of the United States Department of Agriculture in cooperation with the Maine Agricultural Experiment Station to develop new potato varieties that are resistant to potato rust or late blight and therefore not in need of fungicides against this disease. The aim has been to produce a variety that matures early enough for Maine conditions and also one that will be resistant to foliage and tuber infection of the rust disease. Several new varieties have been created that show some promise.

In 1936, a new seedling variety was compared with the Green Mountain variety on unsprayed plots that were subjected to a very heavy infestation of late blight. The results of the data derived from this test are given in Table 39.

TABLE 39

Comparison of Green Mountains and Seedling Number 44488, Resistant to Foliage and Tuber Infection by Late Blight, in Unsprayed Plots

Variety	Yield barrels per acre	Percentage tuber decay in field
Green Mountain	67±5.22	50 per cent or more (exclusive of the 67 bbls.)
New rust proof seedling #44488	119±3.33	None evident

The Green Mountain foliage was rapidly destroyed when the epidemic became severe during August. It is also significant that fully 50 per cent of the tubers of this variety decayed because of rot caused by the late blight fungus. The tubers of seedling #44488, on the other hand, did not decay under the same conditions, and the foliage was only slightly affected.

Several other varieties that have shown considerable resistance to the rust disease, have recently been developed on Aroostook Farm. It is planned to test them for their commercial desirability in the near future.

Insects in Relation to the Transmission of Virus Diseases. G. W. Simpson. Of primary concern in the planning of the experimental work undertaken in connection with this project has been a study of methods of producing foundation Green Mountain seed potatoes. The ultimate aim of this study is seed sufficiently free from disease that no roguing need be done to comply with the requirements for state certification.

With this end in view a number of different localities in Aroostook County have been studied during the past few years. All of these localities, save two, have proven, in practice, to be more or less unfavorable for the production of foundation seed. Most localities have been dropped from the study as soon as it became evident that they were not suited to the production of foundation seed. Seed plots in two rather unfavorable locations have been retained because of the information to be gained from them relative to the spread of mild mosaic.

In one especially favorable location, a three acre seed plot, planted with seed saved from a carefully rogued plot grown on the same farm the previous season, was found to be entirely free from mild mosaic and leaf roll throughout the growing season. This seed plot was examined each week by a competent individual who would have detected any diseased plants had they been evident. The tubers harvested from this seed plot were planted in the spring of 1937 on well over fifty acres. The whole planting was by tuber units. Because of this method of planting, it will be possible to get a very accurate check, during the present season, on any disease that may have been present in the seed plot last season without manifest symptoms, or on disease that may have entered the seed plot during the growing season.

The seed being maintained on the farm under consideration was imported from Canada in 1932 and has been increased each year in a seed plot that was carefully rogued at regular intervals by a representative of the Department of Plant Pathology. In each succeeding year the increase from the seed plot has been planted in commercial fields on the same farm. The progeny of plants growing in these commercial fields has been available to growers of certified seed.

That the seed planted in this one most favorable seed plot was free from mild mosaic and leaf roll during its fifth season since

importation (most such seed "runs out" in two or three seasons) appears to be due to several factors. Perhaps the most important of these is adequate isolation from other potatoes. In this particular instance more than a mile of woodland and open fields intervene before any other potatoes are found. Hence, all the disease with which it was necessary to contend was the small percentage already present in the seed stock used, and there was relatively little danger of reinfection from outside sources. No obviously diseased plant was allowed to remain to be a source of infection within the plot.

Another important factor contributing to the success attained with this seed was early roguing made possible in part by planting the seed plot first, instead of after the main fields as is done by many growers. Roguing was practiced continuously from the time the plants reached a height of six inches until they had reached maturity and started to decline. Six and sometimes eight careful inspections of the seed plot were made during each growing season. Any diseased plants found were carefully dug up, placed in tight bags, and removed a mile or more from the seed plot.

A third factor of no small importance, dependent largely on early planting, was early harvesting of enough seed to plant the seed plot the following season. This practice has been followed during the past three seasons and, although causing some loss in yield, has resulted in seed more free from virus diseases than are tubers allowed to mature naturally. The pulling of the tops before the virus reaches the tubers seems to be the most logical explanation of this result.

Identical practices followed under slightly different ecological conditions, of which the most outstanding was less favorable isolation, have produced seed stocks that contained from one to seven per cent of mild mosaic and some leaf roll. In certain instances evidence shows that some of this disease entered the seed plot from neighboring diseased fields and in other cases it appears to have spread in the seed plot before roguing was completed.

The production of foundation Green Mountain seed in Aroostook County appears to offer definite possibilities to the relatively few individuals who possess or can acquire adequate isolation. Seed suitable for starting such a project is available to any individual wishing to purchase it.

On the other hand it seems increasingly evident that individuals

lacking isolation and so forced to plant close to diseased stock will not at the present time achieve much success in attempting to maintain their own seed of the Green Mountain variety.

Control of Flea Beetles on Potatoes. G. W. Simpson. The infestation of flea beetles on potatoes at Aroostook Farm in 1936 was light. The yields of potatoes obtained from the spray plots to which various materials were applied as control measures were practically identical.

Potato Starch. C. A. Brautlecht. Investigation of starch in Maine grown potatoes and starch from existing Maine starch factories indicates that a quality of starch can be produced in a modern plant which compares favorably with the best quality of imported potato starch. The quantity of potato starch with the standard moisture content of 20 per cent that is obtainable with modern equipment from potatoes with 16 per cent starch content is about 94 per cent of the starch present. With modern factory and equipment, 95 per cent of this starch should be of a superior grade. A modern plant could make a good quality potato flour and powdered starch for human food purposes.

SMALL FRUITS

Variety Trials of Strawberries, Raspberries, and Grapes. Russell M. Bailey and Iva M. Burgess. This work was continued in 1936 with results that appear to justify the following statements as a summary.

Strawberries. A four-year test involving approximately 25 varieties has served principally to demonstrate the superiority of Howard 17 (Premier) for general planting in Maine. Aberdeen has consistently yielded well and ripens its attractive fruit several days later than Howard 17, but because of the softness of its berries this variety can be recommended only to supply nearby markets. Howard Supreme, a pistillate variety producing very dark red berries, may be of value under special conditions. Dorsett and Fairfax have not been thoroughly tested but thus far have been outstanding in flavor while appearing to be inferior in yielding capacity. Catskill is a new variety that appears worthy of further testing.

Raspberries. The raspberry variety trial has included the following that appear promising for use in Maine under certain con-

ditions: Latham should still be recommended as the most dependable variety for general planting in Maine because of its hardiness, attractive fruit and disease tolerance. Newburgh, a relatively new variety, has been superior to Latham in the tests at Highmoor Farm, Monmouth, Maine, and it should be more thoroughly tested throughout the State for use as a market variety. Viking has been outstanding in vigor, fruit quality, and plant type but unfortunately mosaic disease and winter injury have caused such serious damage at times that Viking can be recommended only for special conditions. Monroe has been outstanding as an early variety and should be more widely tested in Maine. Lloyd George produces very large attractive berries over a long fruiting season and can be recommended for home use.

Grapes. Beta has been outstanding for dependability, in ripening its crop, and for heavy yield. The fruit is inferior for table use but satisfactory for preserving. Worden has proven the best of the table varieties included in the variety trial.

BLUEBERRY INVESTIGATIONS. Frederick B. Chandler and Irvin C. Mason. *Pollination.* The results of last season's studies on pollination show that honeybees of types used in many sections of Maine increase the yield of blueberries. Honeybees when properly kept will overwinter very well in the blueberry sections and will assist greatly in pollination when the blueberries are in blossom. There are now about 30 hives of bees in Columbia in the vicinity of Epping Corner.

Experiments have shown that the stigma of the blueberry blossom is receptive for only about four days from time of opening. This means that each blueberry blossom must be visited by a pollen-carrying insect within four days after the blossom opens.

Breeding and Variety Testing. The crosses between some of the improved high-bush varieties of blueberries and selected low-bush varieties have given many plants, most of which were set at Highmoor Farm in July, 1936. These plants showed very little winter injury while many of the named varieties were severely injured. Many more crosses were made this spring and these plants will be taken into the field in 1938 and 1939.

Field Management of the Blueberry. The burning experiments are being continued to study the effects of two and three year burning upon blueberry yields. An effort is also being made to construct

a burning machine to use kerosene or range oil which will burn a strip of blueberry land eight or ten feet wide. The weed burning equipment on the market has given very satisfactory results when used to burn blueberry land. The commercial burners are very slow, however, and by their use a man can burn only one acre a day.

Weed Control. Weed control is still one of the most important operations in blueberry management. The woody plants are best controlled by cuttings while the herbaceous weeds may be controlled by cuttings or chemical sprays. The studies with sulfuric acid are being continued this year. Sulfuric acid is most suited for use on the herbaceous weeds. Several hours of dry hot weather after the application are essential for the best results with sulfuric acid.

Blueberry Insects. Frank H. Lathrop. Observations and experiments on blueberry insect pests were continued during 1936. Especial attention was given the fruit fly, thrips, and flea beetle.

Blueberry Fruit Fly (*Rhagoletis pomonella* Curran). During 1936 the investigation consisted largely of studies of injury to the blueberry bushes resulting from calcium arsenate. Five brands of calcium arsenate, and a mixture of equal parts of calcium arsenate and zinc sulphate, were applied on July 15 to small plots of blueberry land near Harrington. Each dust was applied at the following rates: 6 pounds, 12 pounds, and 24 pounds per acre.

A series of plots was treated in duplicate on blueberries that had previously received applications of copper-lime-arsenic dust on June 17 and June 30. A similar, duplicated series was treated where copper-lime-arsenic dust had not been applied.

The following tentative conclusions were drawn:

1. Injury, apparently caused by calcium arsenate, appeared especially as an aggravation of previous injuries from foliage diseases or leaf-feeding insects.

2. The application of copper-lime-arsenic dust earlier in the season reduced the amount of arsenical injury—probably because the copper-lime-arsenic dust reduced the infection by foliage diseases.

3. The addition of zinc sulphate to the calcium arsenate appeared to have little or no value in reducing arsenical injury.

Non-arsenical Dust for Blueberry Fruit Fly. One means of avoiding arsenical injury to the blueberry plants is, of course, the use of a non-arsenical insecticide. With this in mind a plot of 5

acres of commercial blueberry land near Cherryfield was given an application of derris dust (0.75 per cent rotenone) on July 17 and again on July 27, 1936. The dust was applied at the rate of approximately 6 pounds per acre at each application.

Examination at picking time showed that the berries from the dusted plot contained 9 maggots per 20 ounces of berries, compared to 35 maggots on adjoining, untreated land—a reduction of 74 per cent as a result of the treatment. Although calcium arsenate usually gives somewhat greater reduction, the derris dust seems sufficiently promising to warrant further study.

The Blueberry Thrips (*Frankliniella vaccinii* Morgan). The excessive rainfall that occurred in the spring of 1937 seemed especially favorable for the development of this pest. Tests were made of derris dust (5 per cent rotenone), cube dust (5 per cent rotenone), sulphur dust, and poisoned bran bait for the control of the thrips. Applications were made on May 4, 11, 17, and 26. None of the treatments appeared to have any value.

The Blueberry Flea Beetle (*Haltica torquata* LeConte). During the spring of 1937 the attack of blueberry flea beetles was much less severe in the Mason Bay section of Washington County than was the case in 1936. The pest was more destructive in the Cherryfield and Harrington areas in 1937 than it was in 1936. Severe outbreaks of flea beetles occurred in spots throughout the more westerly blueberry sections of the State.

ANNOUNCEMENTS

John T. Gyger was appointed to the Station Council by the Trustees of the University to fill the vacancy occurring as the result of the retirement of Harmon G. Allen.

William G. Hunton, for many years a member of the Station Council representing the Seed Improvement Association, was retired automatically upon the disorganization of the Seed Improvement Association. The Station Council at its meeting on February 5, 1937, elected Mr. Hunton an honorary member of the Council.

Mr. Fred J. Nutter was elected by the Livestock Breeders' Association to represent their organization on the Station Council.

Mr. Nutter takes the place of Mr. Edgar B. Lord, who has served on the Council for many years.

Dr. Edith M. Patch, associated with the Station as Entomologist since 1904, retired from active service on June 30, 1937. Dr. Frank H. Lathrop was promoted from Entomologist to Entomologist and Head of the Department.

A fellowship was established at the University by the Maine Canners' Association to effect cooperation between the Canners' Association and the Experiment Station in the development of hybrid sweet corn seed for commercial planting. Under the supervision of the Station plant breeder the fellow will have charge of the details of hybrid seed production for the canners. He will assist also in the Station research with hybrid sweet corn development. Mr. Dean M. Bailey was appointed to this fellowship for the year 1937-38. Mr. Bailey is a graduate of the University of Maine, class of 1936.

A fellowship was established at the University by the Eastern States Farmers' Exchange for the purpose of promoting research on stem-end browning of potatoes. Mr. Avery E. Rich was appointed to this fellowship for the year 1937-38. Mr. Rich is a graduate of the University of Maine, class of 1937.

Lester H. Smith was appointed as Graduate Assistant in Biology to aid in pasture research. This appointment becomes effective July 1, 1937, and is made possible through financial assistance from the American Cyanamid Company. Mr. Smith is a graduate of the University of Maine, class of 1937.

Andrew E. Watson was appointed Assistant Agricultural Economist, the appointment to become effective July 1, 1937. Mr. Watson is a graduate of the University of Maine, class of 1934. He received his M.S. degree in 1936.

Mr. John R. Arno was appointed Assistant in Biology, the appointment to become effective July 1, 1937. Mr. Arno is a graduate of the University of Maine, class of 1936. He is employed to assist in the soil survey.

The Experiment Station has undertaken a Soil Testing Service. Farmers of the State wishing their soils analyzed should write the Station for particulars upon the method of taking samples for analysis and the cost of this analysis to them.

PROJECTS FOR 1936-1937

AGRICULTURAL ECONOMICS

An economic study of the dairy industry in Maine.
An economic study of the potato industry in Maine.
Agricultural credit in Maine.
Land use studies in Maine.

BIOLOGY

The relation between shape and yield of apple trees.
Breeding new varieties of apples.
Nursery stock investigations and bud selection in relation to growth, yield, and color differences in the apple.
A study of the cause and possible control of "leaf scorch" of apple trees.
Causes of cross and self sterility in certain plants, particularly the apple, as determined through cytological and genetic study.
A study of picking date, effect of artificial preservatives, and other factors as related to problems of storage of Maine apple varieties.
To determine the cause of russeting of Golden Delicious apples and methods of preventing it.
A study of the fertilizer requirements of the native Maine blueberry.
Breeding investigations with the blueberry.
Blueberry field management.
Fruitfulness in the blueberry.
Weed control in blueberry fields.
Breeding investigations in canning crops with special reference to sweet corn and beans.
The mode of inheritance of milk production and associated characters in cattle.
Nutrition studies in dairy cattle.
The inheritance and nature of resistance to scab *(Cladosporium cucumerinum)* in *Cucumis sativus.*
Breeding and cultural investigations with garden crops.
Land use studies in Maine.
Pasture improvement studies.
Fertilizer experiments with potatoes in rotation with grain and clover.
A study of clover failures in a potato rotation.
A study of various green manuring crops as a means of increasing and maintaining the organic matter content of potato soils in two, three, and four year rotations.
A study of soil conditions and other factors affecting development and control of potato scab.
A study of the physiology of reproduction in poultry.
Influence of anti-rachitic substances on growth in poultry.
The prevention of water heart in rutabagas, browning of cauliflower, and other physiological troubles of *Brassica.*

Fertilizer experiments with sweet corn and beans in a four-year rotation—oats, clover, sweet corn and beans and with sweet corn in a two-year rotation—sweet corn and an annual green manuring crop (mixture of oats and peas).
Cytological studies in species crosses.
Small grain variety test including oats, barley, and wheat.
Investigations dealing with the production of leguminous hays in Maine.
The fertilizer and cultural requirements of small fruits.
The vitamin assay of Maine-grown fruits and vegetables.
Breeding investigation with small fruits, particularly the raspberry and strawberry.
To study the physiological causes of winter injury in raspberries.
A study of methods of improving fertility in orchard soils.

Chemistry

inspection

Inspection of feeding stuffs.
Inspection of fertilizers.
Inspection of foods and drugs.
Inspection of fungicides and insecticides.
Inspection of seeds.
Inspection of gasolines and oils.
Calibration of creamery glassware.
Inspection of milk and cream.
Miscellaneous analyses.

investigation

Chemical analyses in connection with the problem of nutrition and growth of poultry and dairy cattle. (In cooperation with the Biology Department.)
Soil analyses investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm. (In cooperation with the Biology Department.)
A comparison of copper fungicides as to the adherence of the copper contents to potato foliage in spraying and dusting. (In cooperation with the Plant Pathology Department.)
The determination of the amounts of spray residues on apples. (In cooperation with the Entomology Department.)
Miscellaneous analyses.
Design and plans for a modern potato starch factory for Aroostook County.
Starch content of potatoes from specific gravity.

Entomology

Aphid investigations with special reference to the different food plants of migratory species.

A study of apple maggot problems, including dispersion.
Insects affecting the blueberry.
The cabbage maggot.
Control of the cabbage maggot.
Experiments in the control of the cucumber beetle and other insects.
Cutworms affecting field and garden crops.
Insects in relation to the transmission of virus diseases of potatoes.
Garden slug control.
Wireworms affecting field and garden crops.
The Mexican bean beetle.
The carrot rust fly.
A study of the potato flea beetle with special reference to its control.

HOME ECONOMICS

The economic utilization of electricity in food preparation in Maine rural homes.
The factors affecting the cooking quality of potatoes.
A study of the financing by Maine families of the higher education of their children in Maine institutions.
Food habits and nutritional status of children in selected communities in Maine.
The effect of an improved diet upon the health and nutritive condition of grade school children in Mars Hill, Maine.
The antiscorbutic value of home canned pickles of various types used in Maine.
The economical management of kerosene cook stoves to secure palatability of product in Maine farm households.

PLANT PATHOLOGY

Apple scab control.
Blueberry diseases.
Cucurbit disease control.
Differentiation and dissemination of potato virus diseases.
Dusting and spraying potatoes.
Economic effects and control of potato virus diseases.
Histology and ecology of potato tuber rots.
Identification and dissemination of causes of potato rots.
Seed disinfection of potatoes.
Stem-end browning of potato tubers.
Epidemiology, economic effects and control of bacterial wilt (Stewart's disease) of corn.
Plant disease survey and miscellaneous diseases. Annual recording, through correspondence and observations, of the prevalence and severity of plant diseases, and preliminary experiments on miscellaneous diseases that develop importance.
Apple tree winter injury: effects, recovery and prevention.

PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and may be bound with the annual report as an appendix thereto. Miscellaneous publications, consisting of newspaper notices of bulletins and newspaper articles which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

Bulletins Issued in 1936-1937

No. 385. An Economic Study of Milk Production Costs in Herds of Producer-Distributors in Maine. 52 pages.
No. 386. Evaluation of Certain Factors Affecting the Cost of Using Utensils on Electric Heating Units. 104 pages.
No. 387. Report of Progress for Year Ending June 30, 1937. 106 pages.

Official Inspections Issued in 1936-1937

No. 160. Commercial Feeding Stuffs, 1935-36. 52 pages.
No. 161. Commercial Fertilizers, 1936. 48 pages.
No. 162. Commercial Agricultural Seeds, 1936. Fungicides and Insecticides, 1936. 24 pages.
No. 163. Foods and Drugs. 14 pages.

Abstracts of Papers Published by the Station in 1936-1937 but Not Included in the Bulletins

A complete list of all the bulletins issued by and from the Station in 1936-37 is given on page 251 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

Winter Injury to Apple Trees*

In previous work done by the Maine Agricultural Experiment Station, no definite attempt had been made to study winter injury

* This is an abstract of a paper by M. T. Hilborn, having the same title and published in Ann. Rpt. Maine State Pomol. Soc. 1934-1935, pp. 70-76. 1936.

or to discover a means of preventing the recurrence of similar losses.

A study of weather records and of the data from artificial freezing experiments indicates that the winter injury caused by the winter of 1933-34 occurred in November, 1933, and not during later months. From the phenomena of maturity and hardening off, it is inferred that apple trees were immature in November, 1933, probably because of the late autumn rainfall.

A study of representative winter-killed and winter-injured trees that have recovered has led to a method whereby the probable recovery of trees injured by low temperature may be predicted.

It is known that hardy stocks affect the hardiness of the scion. Experiments should be made here on the interaction of stock and scion and its effect upon hardiness, using the most promising varieties.

SOME EPIXYLOUS FUNGI OF MAINE†

Seventy-three wood-inhabiting fungi are included in this list. Of these the genus *Daedalea* is represented by 3 species, *Favolus* by 2, *Fomes* by 12, *Hydnum* by 2, *Hymenochaete* by 1, *Irpex* by 1, *Lenzites* by 3, *Merulius* by 1, *Panus* by 1, *Peniophora* by 1, *Phlebia* by 1, *Polyporus* by 23, *Poria* by 9, *Radulum* by 1, *Schizophyllum* by 1, *Septobasidium* by 1, *Stereum* by 6, and *Trametes* by 4 species.

Of these the following are first reports from Maine. *Fomes pini* (Thore) Lloyd, *Lenzites trabea* (Pers.) Fr., *Polyporus albellus* Peck, *P. dichrous* Fr., *P. fumosus* (Pers.) Fr., *P. velutinus* Fr., *Poria laevigata* Fr., *Trametes americana* Overh., and *T. heteromorpha* (Fr.) Lloyd.

Polyporus compactus Overh. is reported for the first time outside of Pennsylvania, and *Stereum purpureum* (Pers.) Fr. is reported for the first time on a coniferous substratum.

REPORT ON WOUND DRESSINGS USED IN THE COLLEGE ORCHARD DURING 1934 AND 1935‡

The results of the preliminary work done in 1934 indicate that a canvas covering over a wound dressing is not satisfactory. Water

† This is an abstract of a paper by M. T. Hilborn and F. H. Steinmetz, having the same title and published in Plant Dis. Rptr. 20:306-309. 1936.

‡ This is an abstract of a paper by M. T. Hilborn, having the same title and published in Ann. Rpt. Maine State Pomol. Soc. 1934-1935, pp. 44-47. 1936.

glass (sodium silicate) proved to be an unsatisfactory wound dressing as it was not durable.

In 1935 a preliminary study of 18 wound dressings, of which 3 were home mixed and 15 were commercial preparations, indicates that only 3 show much promise under Maine conditions. The retarding of callus formation by toxic materials is apparent in many of the otherwise promising compounds. Bordeaux powder and linseed oil showed an average of only 3 mm. callus growth, while Liquid Elastigum showed 7 mm. However, the amount of callus formation is not the best measure of the efficiency of a wound dressing and when other requirements are considered many of the dressings that did not retard callus formation to any appreciable extent proved worthless.

Liquid Elastigum, Leonard Tree Compound, Valdura, Corona, and Vultex are all dark in color and when applied to the southwest side of the trunk showed a tendency to crack and peel off.

Paraffin and three types of grafting wax were subject to changes in temperature and ran off in summer and cracked in winter.

Clintark showed a tendency to pull away and crack around the edges of the wound where callus was forming.

Hood River Tree Paint easily flaked off when dry. Shellac was not durable and easily weathered away.

Plastic Elastigum is one of the three that showed the most promise for treating wounds in crotches where a cavity had formed. This was the only one of the commercial preparations that ranked up with the home mixed compounds. These, white lead, Bordeaux mixed with rapeseed oil, and Bordeaux mixed with linseed oil, were all satisfactory. Observations indicate that the Bordeaux-oil mixture is the most durable of the three. It has the disadvantage of not remaining in good condition very long after mixing, but has a great advantage in that it is a good disinfectant and thus requires only one treatment to a wound, no previous treatment with a disinfectant being necessary.

A Bacterial Wilt and Soft Rot of the Potato in Maine[a]

A bacterial wilt and soft-rot disease has been observed from time to time in Aroostook County, Maine. The disease generally

[a] This is an abstract of a paper by Reiner Bonde, having the same title and published in Phytopathology 27:106-108. 1937.

is noted in late summer when the tubers are well formed. The first evidence of the disease is a wilting of leaves and individual stems. The leaves on the wilted stems become chlorotic and gradually die. They sometimes show a marginal dying and the vascular bundles of the stems appear more or less discolored. The tubers originating from the wilted stems are often decayed. The decay appears to begin in the region of the vascular system and thence extends into the pith, causing a white or cream-colored rot. Often the entire center of the tuber disintegrates, leaving a mere shell. These hollow tubers are found in many of the bins of potatoes from affected fields.

The tubers from affected plants, if harvested before the rot sets in, often show a characteristic cracking.

This disease is perpetuated through the seed tubers and some growers are of the opinion that the use of new seed stocks has eliminated the disease from their respective farms.

BREEDING FOR RESISTANCE TO LATE BLIGHT IN THE POTATO[1]

The reduction in yields of potatoes in the United States caused by late blight is estimated at more than 9,000,000 bushels for a ten-year average (1926-1935). The yearly loss in Maine varied from 662,000 bushels to 12,655,000 bushels for the same period. It would be highly desirable to secure suitable commercial varieties of potatoes that are resistant to this disease.

The United States Department of Agriculture, in cooperation with the Maine Agricultural Experiment Station, is attempting to produce new varieties of potatoes that are resistant to the ravages of the disease. Many new seedling varieties have been produced on Aroostook Farm. Some of these new varieties are highly resistant to disease and were not injured by late blight under the conditions of a severe epidemic. The Green Mountain variety grown under the same conditions was killed by the blight fungus and many of the tubers showed rot in storage. The yields of some of these resistant seedlings have compared fairly well with the Green Mountain variety when grown on Aroostook Farm, Presque Isle, Maine.

These new blight resistant varieties will be given extensive

[1] This is an abstract of a paper by F. J. Stevenson, E. S. Schultz, C. F. Clark, W. P. Raleigh, Lillian C. Cash, and Reiner Bonde, having the same title and published in American Potato Journal 13:205-218. 1936.

tests with growers as soon as the seed stock can be increased sufficiently.

Recent Developments in Potato Breeding for Resistance to Virus Diseases‖

New seedlings and other varieties of potatoes are being studied for the purpose of learning whether resistance to certain virus diseases, namely, mosaic, spindle tuber, and leaf roll, exists and whether this resistance is inherited.

The potato varieties and seedlings studied varied in their reaction to the different viroses. Some are completely resistant; some fail to contract the virus in the field, but become infected in graft tests; others rarely contract virus in the field but become infected in grafts; still others contract the virus readily both by field exposure and by the graft method.

In the experiments reported, one seedling (41956) has never contracted latent mosaic in the field or by artficial inoculation methods and appears to be immune to this disease. Katahdin was highly resistant to latent mosaic in the field, but became infected when the grafting method was used.

The studies show that resistance to mild mosaic is inherited and that the progeny from certain crosses may be expected to give seedling varieties that are resistant to this disease. It is of interest that some seedlings were produced that are resistant to both mild mosaic and late blight.

No variety or seedling was found to be resistant to the vein-banding virus (rugose mosaic). Some seedlings were, however, very tolerant and were not seriously affected when this disease was present.

Most seedlings tuber-grafted with spindle tuber became infected. Different varieties show great variation in symptoms, some being very tolerant. Field-exposure tests for leaf-roll spread were not effective in Maryland, susceptible controls remaining healthy.

‖ This is an abstract of a paper by E. S. Schultz, C. F. Clark, W. P. Raleigh, F. J. Stevenson, Reiner Bonde, and J. H. Beaumont, having the same title and published in Phytopathology *27*:190-197. 1937.

SOME OBSERVATIONS AND CURRENT STUDIES OF WINTER INJURY TO APPLE¶

A survey made in the spring of 1934 of 889 commercial orchards showed that 40.3 per cent of the bearing apple trees, and 3.9 per cent of the nonbearing apple trees, were severely winter-injured. A previous survey in 1907 revealed similar results. A compilation of these surveys and field observations indicates that some of the varieties that are definitely nonhardy in Maine are Baldwin, Gravenstein, Ben Davis, Stark, Northern Spy, Tolman, St. Lawrence, King David, and Winter Banana.

By the use of an artificial freezing technique it was possible to study the relative hardiness of apple varieties in the laboratory. These studies indicate that in Maine the Cortland, Macoun, McIntosh, Milton, and Oldenburg varieties are hardy in comparison with Delicious, Golden Delicious, Haralson, Northern Spy, Orleans, Stayman, and Wealthy, which are intermediate, and Baldwin, Ben Davis, Gravenstein, St. Lawrence, and Stark which are nonhardy. This artificial freezing technique is used in connection with the apple breeding work which it speeds up by eliminating unsuitable material.

Severe trunk damage appeared in 1935 and 1936 in Maine in McIntosh, a leading commercial variety, and Cortland. It has again focused attention on the possibilities of top- and double-working in order to secure the advantage of superior hardiness of the trunk.

WIREWORM CONTROL IN RELATION TO POTATO GROWING§

Thirty per cent of the potato crop is sometimes injured by wireworms in certain communities. Much of this loss is avoidable. In order to efficiently control wireworms it is necessary to know what wireworms are, what species are present in the soil, and something of the life history of the destructive species.

¶ This is an abstract of a paper by J. H. Waring and M. T. Hilborn, having the same title and published in Proc. Amer. Hort. Sci. 34 (for 1936) :52-55. 1937.

§ This is an abstract of a paper by J. H. Hawkins, having the same title and published in Jour. N. H. Hort. Soc. vol. 1, pp. 19-25. 1937.

In addition to the above topics this paper discusses the following: How wireworms affect potatoes, taking samples to establish wireworm populations, the relation of wireworm populations to potato injury, land utilization in relation to wireworm control, and cultivation and crop rotation as affecting wireworms.

As a summary, a list of recommendations for wireworm control is given. Chief of these recommendations are: Find out the number of wireworms present and avoid planting where more than three wireworms per square yard are present. Use cultivated crops other than potatoes until the wireworm population is reduced to a point of safety to potatoes. Utilize the best potato soil free from wireworms as often as possible by using a green manure crop in the rotation. Once the soil is free of wireworms avoid seeding to long-standing grass crops. Harvest potatoes from infested soil early in order to avoid unnecessary wireworm injury.

METEOROLOGICAL OBSERVATIONS

The Station is indebted to the Department of Physics of the University for the meteorological summary for Orono for 1936 which appears on the following page.

The instruments used are located on the University campus at Lat. 44° 54′ 2″ N., Long. 68° 40′ 5″ W., Elevation 135 feet. They are the same as those used in preceding years and include: maximum and minimum thermometers, rain gauge, self recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of sixty-eight years.

METEOROLOGICAL SUMMARY FOR 1936
U. of M. Orono, Maine

1936	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	50	48	72	79	86	88	90	90	88	73	59	53	—	—
Lowest temperature	−16	−10	−7	26	26	39	45	38	27	20	3	−6	—	—
Mean temperature	20.96	18.86	39.62	41.60	54.46	63.23	65.96	64.84	56.81	46.43	28.85	25.37	43.92	
Mean temperature in 68 years	16.46	19.01	30.15	39.43	51.04	61.33	67.21	65.74	60.08	49.14	37	23.01	43.30	
Total precipitation in inches	5.90	3.30	5.37	2.55	3.08	2.81	1.87	1.45	2.58	4.71	2.12	6.11	—	41.85
Mean total precipitation in 68 years	3.93	4.14	3.62	2.86	3.25	3.46	3.41	3.40	3.47	3.93	3.51	3.56	—	42.54
Number of days with .01 inch precipitation or more	11	7	10	10	10	9	8	9	9	8	13	9	—	113
Snowfall in inches	19.50	16	13	2.50	—	—	—	—	—	—	5	2	—	58
Mean snowfall in 68 years	21.55	21.17	13.64	5.37	—	—	—	—	—	.70	5.86	15.06	—	83.35
Number of clear days	14	20	14	8	14	13	9	12	9	13	3	5	—	134
Number of partly cloudy days	2	1	8	8	9	7	17	11	10	7	9	13	—	102
Number of cloudy days	15	8	9	14	8	10	5	8	11	11	18	13	—	130
Average wind velocity in miles per hour	5.09	4.41	4.01	5.51	5.43	4.30	3.75	3.03	3.80	4.27	4.31	5.23	4.43	

METEOROLOGICAL SUMMARY
U. of M. Orono, Maine
January-June, 1937

1937	January	February	March	April	May	June
Highest temperature	50	61	53	75	96	98
Lowest temperature	0	−4	−2	22	36	44
Mean temperature	25.57	27.84	29.19	44.2	57.53	62.69
Mean temperature in 69 years	16.59	19.14	30.14	39.5	51.13	61.35
Total precipitation in inches	2.86	2.53	3.22	2.48	4.67	4.74
Mean total precipitation in 69 years	3.91	4.12	3.61	2.85	3.27	3.48
Number of days with .01 inch precipitation or more	8	7	4	8	7	16
Snowfall in inches	2.75	8.75	17	.5	—	—
Mean snowfall in 69 years	21.27	20.99	13.69	5.29	—	—
Number of clear days	13	15	16	13	13	8
Number of partly cloudy days	9	5	10	4	10	11
Number of cloudy days	9	8	5	13	8	11
Average wind velocity in miles per hour	4.07	4.35	4.56	5.16	4.26	3.94

Weather data are taken at Aroostook Farm, Presque Isle, in cooperation with the United States Department of Agriculture, Weather Bureau. These data include maximum and minimum temperatures and records of precipitation.

METEOROLOGICAL SUMMARY
Aroostook Farm, Presque Isle, Maine
January-June, 1937

1937	January	February	March	April	May	June
Highest temperature	47	44	40	72	93	83
Lowest temperature	−15	−16	−9	15	30	34
Mean temperature	18.5	19.0	20.9	39.3	55.0	60.9
Mean temperature in 11 years	13.4	12.6	24.6	37.7	50.9	60.1
Total precipitation in inches	1.99	1.81	3.82	1.62	4.95	3.69
Mean total precipitation in 11 years	2.64	1.37	2.46	2.32	3.35	3.83
Number of days with .01 inch precipitation or more	5	6	7	5	12	10
Snowfall in inches	5.00	0.86	1.00	—	—	—
Mean snowfall in 11 years	14.92	9.21	5.14	2.48	.01	—
Number of clear days	13	10	13	13	9	7
Number of partly cloudy days	8	6	12	9	13	12
Number of cloudy days	10	12	6	8	9	11
Average wind velocity in miles per hour	—	—	—	—	—	—

METEOROLOGICAL SUMMARY FOR 1936
Aroostook Farm, Presque Isle, Maine

1936	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	39	39	62	72	81	85	85	83	79	67	60	47		
Lowest temperature	–15	–16	–14	19	22	37	41	36	23	15	–2	–11		
Mean temperature	12.2	9.7	31.5	37.2	49.7	62.3	62.5	60.3	54.6	42.3	25.1	17.9	38.8	
Mean temperature in 10 years 1927-1936	12.9	12.0	25.0	37.6	50.5	60.1	65.4	62.9	55.1	44.4	30.6	17.1	39.5	
Total precipitation in inches	4.27	1.73	4.11	2.55	6.36	4.18	3.52	4.03	4.56	5.19	1.96	2.32		44.78
Mean total precipitation in 10 years	2.71	1.33	2.32	2.39	3.19	3.84	4.19	3.01	3.83	3.61	2.21	2.03		34.66
Number of days with .01 inch precipitation or more	12	11	13	12	20	11	16	10	13	13	7	5		143
Snowfall in inches	21.10	13.00	1.25	17.75	—	—	—	—	—	—	9.00	6.10		68.20
Mean snowfall in 10 years	15.91	10.04	5.55	2.73	—	—	—	—	—	1.93	3.31	11.68		51.15
Number of clear days	12	10	8	5	4	9	6	9	15	12	4	11		105
Number of partly cloudy days	4	5	1	4	5	11	8	3	2	4	—	4		51
Number of cloudy days	15	14	22	21	22	10	17	19	13	15	26	16		210
Average wind velocity in miles per hour	—	—	—	—	—	—	—	—	—	—	—	—	—	—

REPORT ON THE FINANCES OF THE STATION

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, Purnell Fund, and Bankhead-Jones Fund accounts are also audited by the Office of Experiment Stations acting for the Secretary of Agriculture of the United States in accordance with federal law.

The income of the Station from federal and state appropriations for the year that ended June 30, 1937, was:

U. S. Government, Hatch Fund	$15,000.00
U. S. Government, Adams Fund	15,000.00
U. S. Government, Purnell Fund	60,000.00
U. S. Government, Bankhead-Jones Fund	10,346.08
State of Maine, Mill Tax, Other Income, Sales, etc.	50,229.41
State Department of Agriculture	14,875.61
Total Income	$165,451.10

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations. The cost of printing the Station bulletins is paid by the University from funds other than those mentioned above.

At Aroostook Farm there are in connection with the cooperative work with the Federal Department of Agriculture certain expenditures for the Department made from sales of crops from Department investigations. These expenditures are not included in the tabular statements. They are carried as distinct and separate accounts, always with credit balances on the Station ledger.

REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1937
Disbursements

	Federal Funds				State Funds			Totals
	Hatch	Adams	Purnell	Bankhead-Jones	Bankhead-Jones Offset	Mill Tax, Other Income, Sales, etc.	Inspections	
Personal Services								
Salaries	$ 8,450.03	$11,550.05	$37,444.04	$ 4,757.62	$ 9,579.92	$11,472.21	$12,050.02	$ 95,303.89
Labor	1,775.73	1,477.04	9,697.67	2,705.18	22.18	11,274.62	612.11	27,564.53
Supplies and Materials								
Stationery and office supplies	446.19	3.41	255.44	77.22	3.77	70.44	8.45	864.92
Scientific supplies, consumable	172.03	24.88	992.48	199.66	105.36	615.48	689.77	2,799.66
Feeding stuffs	48.85	——	1,503.10	745.97	——	1,065.12	——	3,363.04
Fertilizers	33.02	——	1,785.06	99.01	——	197.54	——	2,114.63
Sundry supplies	126.56	84.61	996.33	227.36	15.00	2,457.87	60.96	3,968.69
Communication Service	425.59	——	59.55	——	——	238.58	107.92	831.64
Travel Expenses	1,498.50	——	2,969.29	563.54	206.43	1,167.92	237.20	6,642.88
Transportation of Things	107.56	10.72	154.82	27.21	——	150.89	92.95	544.15
Printing and Illustration Publications	118.18	——	23.25	——	.97	38.77	——	181.17
Heat, Light, Water, and Power	746.77	32.19	858.59	63.10	.52	3,424.24	397.84	5,523.25
Contingent	22.09	——	180.52	33.35	——	132.83	10.00	378.79
Equipment								
Furniture, furnishings, and fixtures	112.55	——	385.37	178.49	7.53	194.86	13.17	891.97
Library	467.76	147.24	87.54	8.05	15.52	240.55	38.91	1,005.57
Scientific equipment	240.68	365.86	1,167.76	17.03	262.21	424.22	536.77	3,014.53
Tools, machinery, and appliances	55.66	691.86	976.54	154.94	——	2,029.02	9.99	3,918.01
Livestock	25.00	——	248.15	455.00	——	156.55	——	884.70
Buildings and Land	127.25	612.14	214.50	33.35	126.67	1,686.71	9.55	2,810.17
Total	$15,000.00	$15,000.00	$60,000.00	$10,346.08	$10,346.08	$37,038.42	$14,875.61	$162,606.19